User Manual

TWS Mk VI

Travelling Wave Fault Locator

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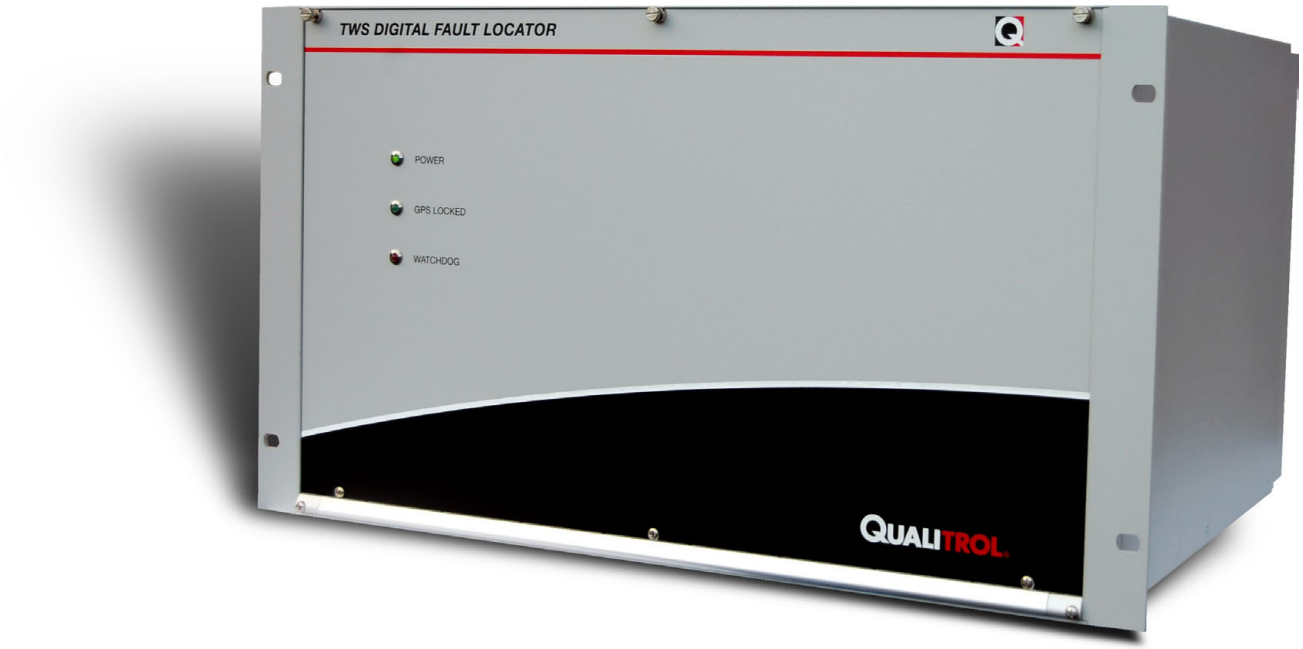

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1. Health & Safety at Work etc. Act 1974 Section 6.1©

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All usage of this product must be in accordance with this manual if there is any doubt about any aspect relating to the correct use of the product please contact:

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2. Overview

This document is split into three main sections. The first section titled “Introduction” gives a brief overview of a TWS (Travelling Wave System) followed by a description of the hardware characteristics of a TWS. The second section titled “Installation” describes the steps taken to physically install a TWS. The third section titled “TWS Commissioning and Testing” involves configuring the TWS software and finally testing the fully installed unit.

3. Introduction

The TWS is designed to accurately locate faults on high voltage, overhead line feeders that may include lengths of cable. It can give useful results on more complicated networks including some branches.
The preferred location is a substation where more than one feeder is connected to the busbar. The TWS depends on the measurement of current transients on the secondary side of the main protection current transformer. This method can only be applied at points on the system where current transformers are available.
At substations where only one feeder connects to a transformer it will be necessary to measure voltage transients from a suitable voltage transducer. Contact QUALITROL for further details on measuring voltage transients.

3.1. Standard Equipment

As shown in Figure 1a and 1b below a standard TWS comes equipped with: -
(a) One TWS chassis with: -
internal power supply, solid state flash drive, CPU Card, GPS module, modem and line modules (maximum of 8). There are also external connections for RJ45 Ethernet, four alarm outputs, IRIG B time synchronisation output and a serial port.
(b) GPS antenna with a ten meter lead (extension cables are available, see section 4.9)
(c) Split core inductive couplers and associated nylon washers, nuts and screws. (3 inductive couplers for each line module)
(d) Lightning surge protection device
(e) Telephone connection cable
(f) Linux operating system and the latest TWS firmware.

Figure 1a and 1b

3.2. Typical Scheme

Figure 2 below is a typical scheme of two TWSs installed at either end of an overhead line. Each TWS monitors the current transients on phase A, B and C of the overhead line feeders. The main PC is usually situated in the control room and is used to retrieve timestamps of current transients from both TWSs at either end of the line and calculates distance to fault.

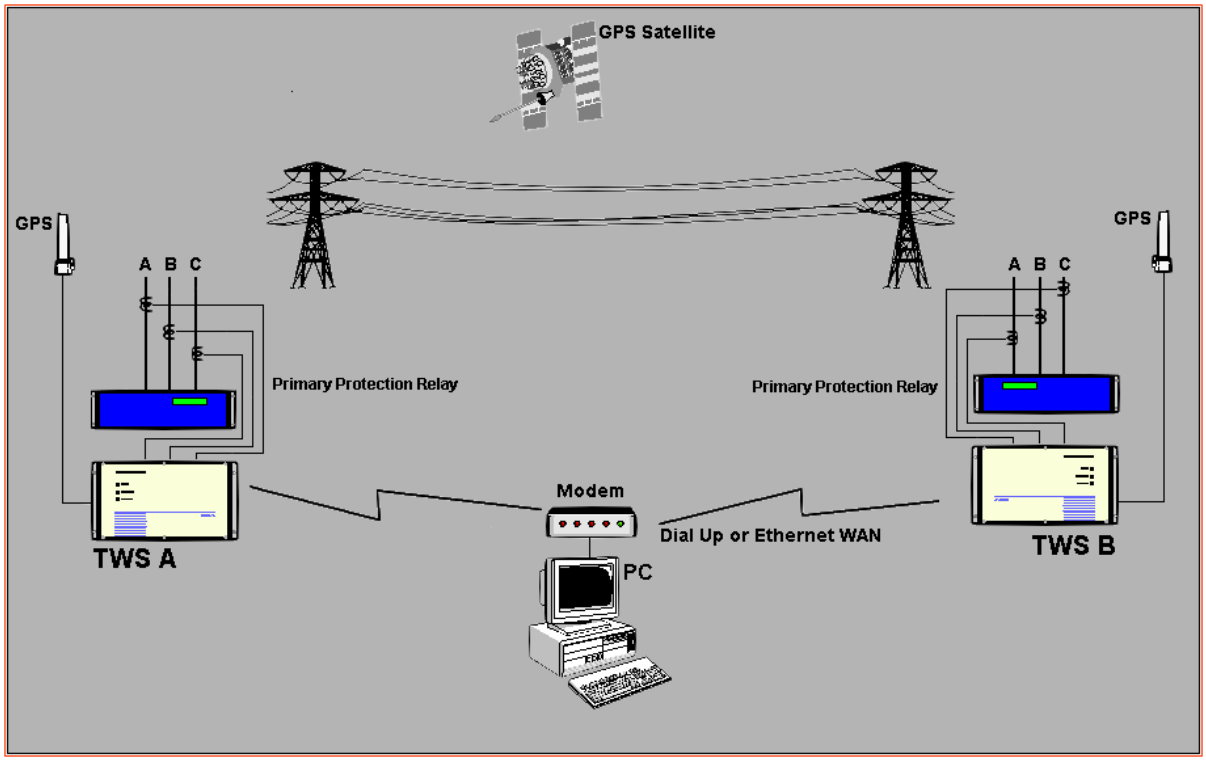


Figure 2 – Typical Scheme

3.3. Control Room Equipment/Software

The required control room equipment consists of a PC running Windows 2000 or XP.

The control room PC should have the following: -

- Modem hardware installed (if modem connection option is selected)
- Ethernet port available (if LAN connection option is selected)
- TWSBase2000 software installed (for further information consult the TWSBase2000 user manual)
- Network Editor software installed (for further information consult the TWSBase2000 user manual)
- Poll and Display software installed (optional, for further information consult the PAD user manual)

3.4. Transport and Storage conditions

A storage temperature of -40 to +70 ^{o}C is acceptable. The equipment must be kept dry. The packing provided is suitable for road and air freight.

3.5. Mechanical Characteristics of TWS

Enclosure	6U, 19” rack mountable chassis
Width	448.8mm (17.68”)
Depth	386mm (15.21”)
Height	266.7mm (10.5”)
Weight	18kg (40 lbs)

3.6. Climatic Conditions

The operating temperature range is 0 to +55^{o}C, relative humidity from 5% to 95% non-condensing.

3.7. Electrical Conditions of TWS

3.7.1. Power supply, consumption and earthing requirements

The input voltage will depend on power supply option at time of purchase.

The two power supply options are:

Unit A

This unit is designed for nominal 48V dc battery supplies. The Substation Module operates to specification on this unit for dc supplies in the range 48V(-20% to + 10%).
Maximum Power Consumption if fully equipped is 120W.

Unit B

This unit is designed for dc supplies operating within the limits 80 to 240V, or 50/60Hz ac supplies within the voltage range 90to 250V.
Maximum Current Consumption if fully equipped is 120W.

Unit B allows the equipment to be used on ac supplies, which may be useful for test purposes. However, in the interests of supply reliability, we strongly recommend you normally operate the equipment on dc storage battery supplies.

3.8. Hardware Overview

The following section illustrates the TWS hardware from different angles.

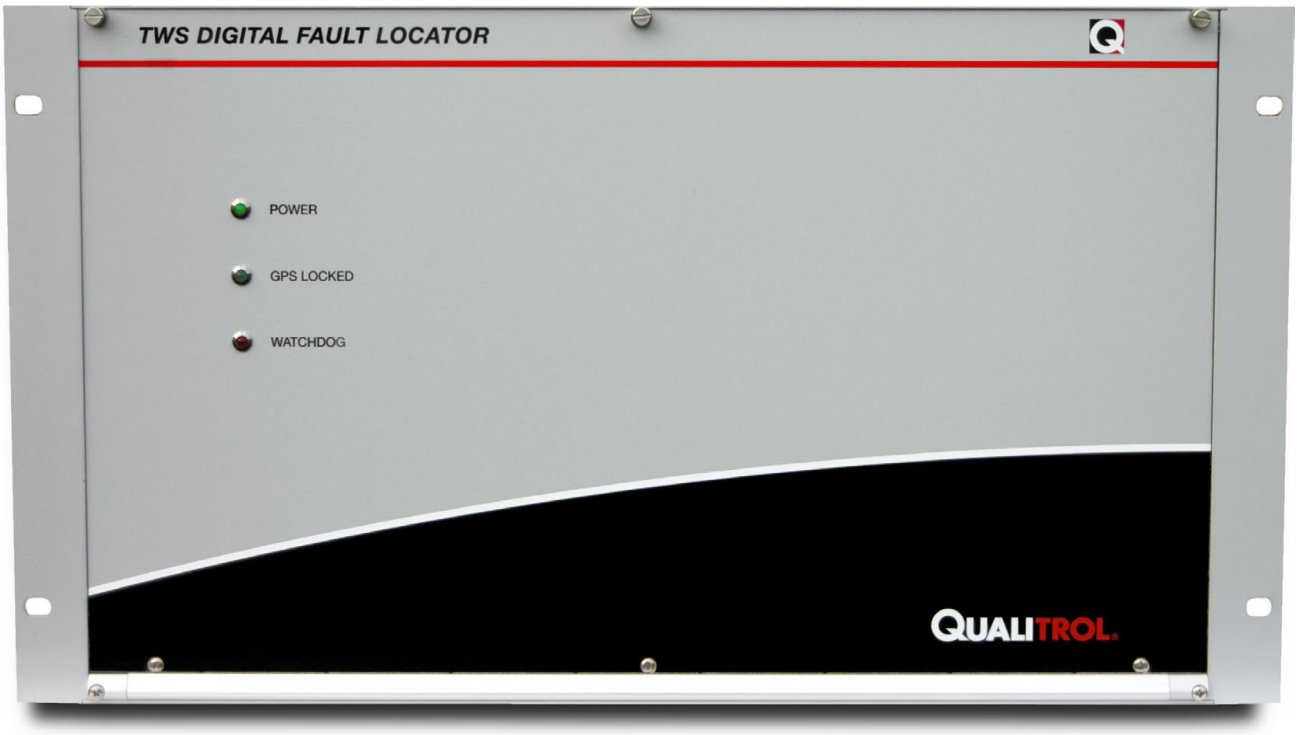


Figure 3 – Front view of TWS

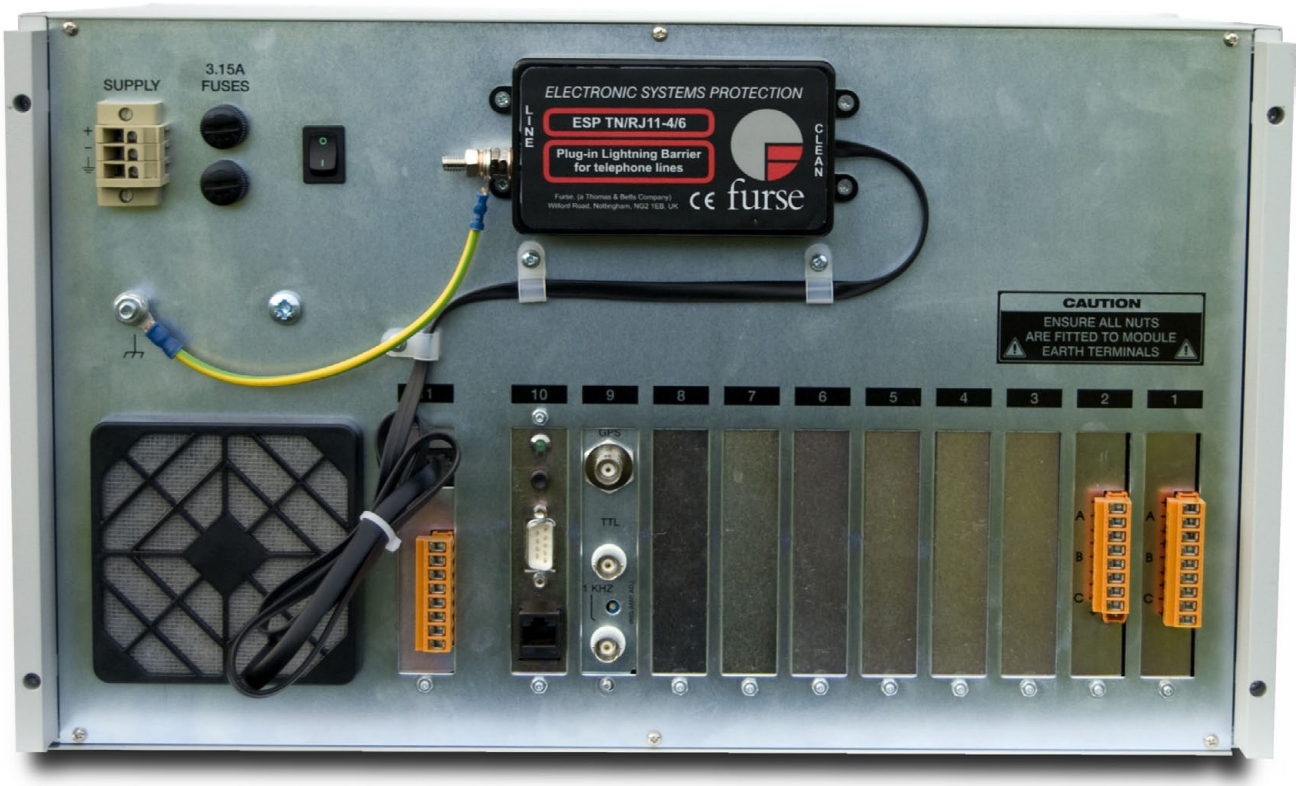


Figure 4 - Rear view of TWS

Figure 5 - Detailed rear view of TWS

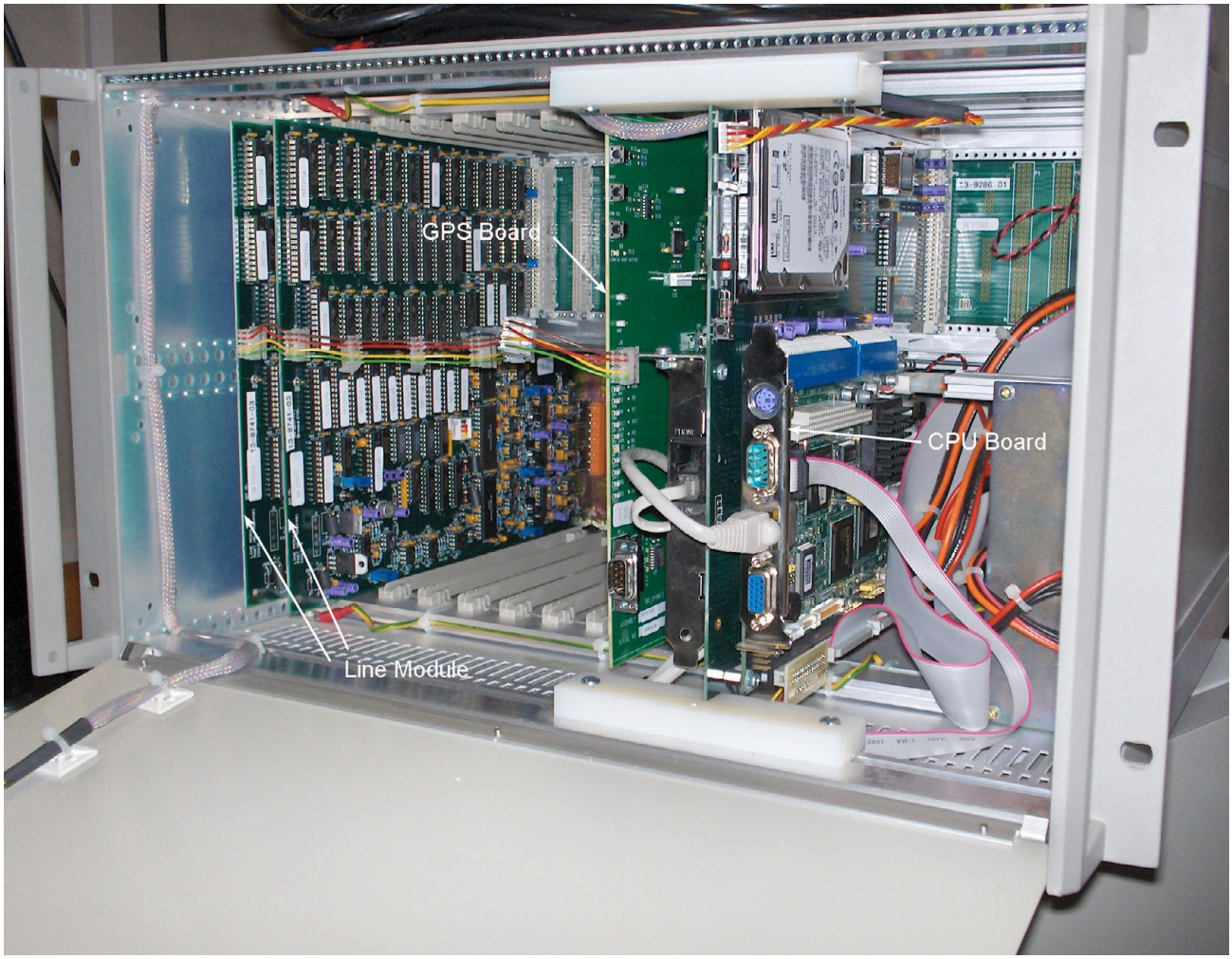


Figure 6 – Internal view of TWS

4. Installation

On receipt of the equipment and accessories they should be examined for any damage or shortages which should be immediately reported to QUALITROL.
Installation of the TWS consists of: -
a. Mounting the TWS in a suitable 19” rack.
b. Connecting the supply voltage to the TWS.
c. Linking the TWS to a telephone line (Lightning surge protection device) if applicable.
d. Connecting an external modem if applicable.
e. Connecting the TWS to the local area network using the twisted pair Ethernet port if applicable.
f. Connecting the split core CTs to the secondary (protection) wiring.
g. Attaching and positioning the GPS antenna.
h. Connecting output alarms.

4.1. Mounting the TWS

The TWS has a 19 inch rack mount form factor with 2 mounting holes to the far left and 2 mounting holes to the far right on the front of each unit.

4.2. The Supply Voltage

Check that the voltage of the proposed supply matches the voltage of the TWS model ordered. If it matches connect the supply voltage to the polarity labelled connections marked SUPPLY or 48 VDC at the rear of the TWS as shown in figure 7 below. A provision for earthing the unit is provided by the stud connection marked ⏚ at the rear of the TWS. The Earth connection should be made by 6mm^2 tri-rated earth cable.

Figure 7 - Supply Voltage

4.3. The Link from the TWS Internal Modem to the Telephone Line

As shown in figure 8 below the telephone line is connected to the internal modem via a data surge protection device.

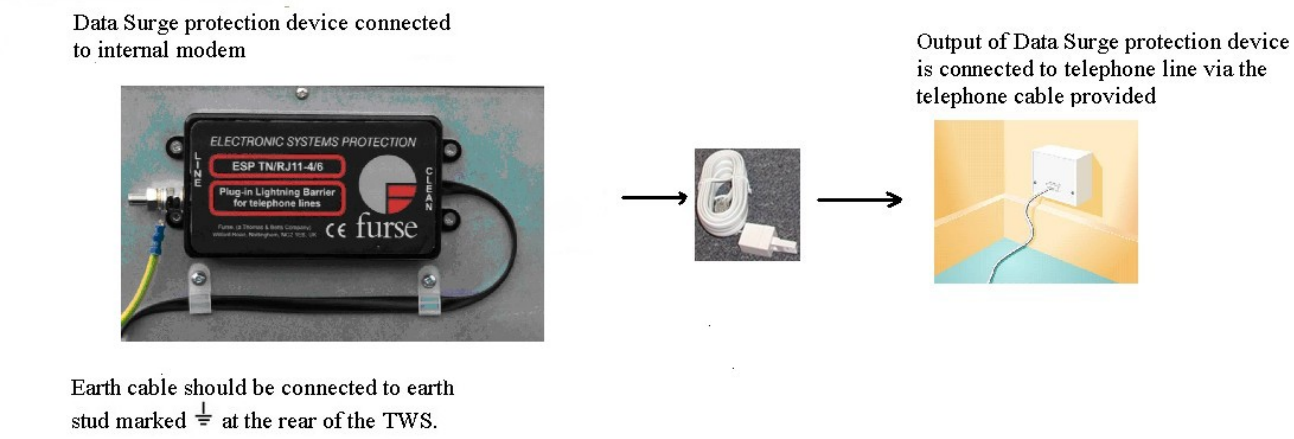

Data Surge protection device connected to internal modem
ELECTRONIC SYSTEMS PROTECTION
ESP TN/RJ11-4/6
Plug-in Lightning Barrier for telephone lines
furse
Output of Data Surge protection device is connected to telephone line via the telephone cable provided
Earth cable should be connected to earth stud marked ⏚ at the rear of the TWS.

Figure 8 - Connecting Telephone line to data surge protection device

4.4. Connection to External Serial Port COM 2

The external serial port com 2 may be used either for an external modem (see appendix A) or for a DNP connection (see appendix D) to interface to a Scada system. A standard modem cable can be used to connect the external modem to the "Com port 2" on the rear of the TWS. Figure 9 below shows the pin assignment on "Com port 2".

Pin	Signal name
1	Data Carrier Detect (DCD)
2	Receive Data (RX)
3	Transmit Data (TX)
4	Data Terminal Ready (DTR)
5	Signal Ground (GND)
6	Data Set Ready (DSR)
7	Request to Send (RTS)
8	Clear to Send (CTS)
9	Ring Indicator (RI)

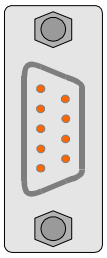


Figure 9 - External serial port COM 2 connections Pin Assignments

The external serial port com 2 may be used either for an external modem or for a DNP connection to interface to a Scada system. The DNP feature may be enabled by web page, see section 5.7.1.

4.5. Connecting Ethernet

An Ethernet connection is available at the rear of the TWS. The TWS is assigned the default IP address of 10.75.8.46 when it leaves the factory. The IP address can be re-configured using the built in web page feature described in section 5.4 of this manual. See location of TWS ethernet port in figure 5.

The Web Page can be accessed via modem or Ethernet.

4.6. Connecting the Inductive Couplers (Transducers)

The inductive couplers are shown in Figure 10 and 11 as shown below:

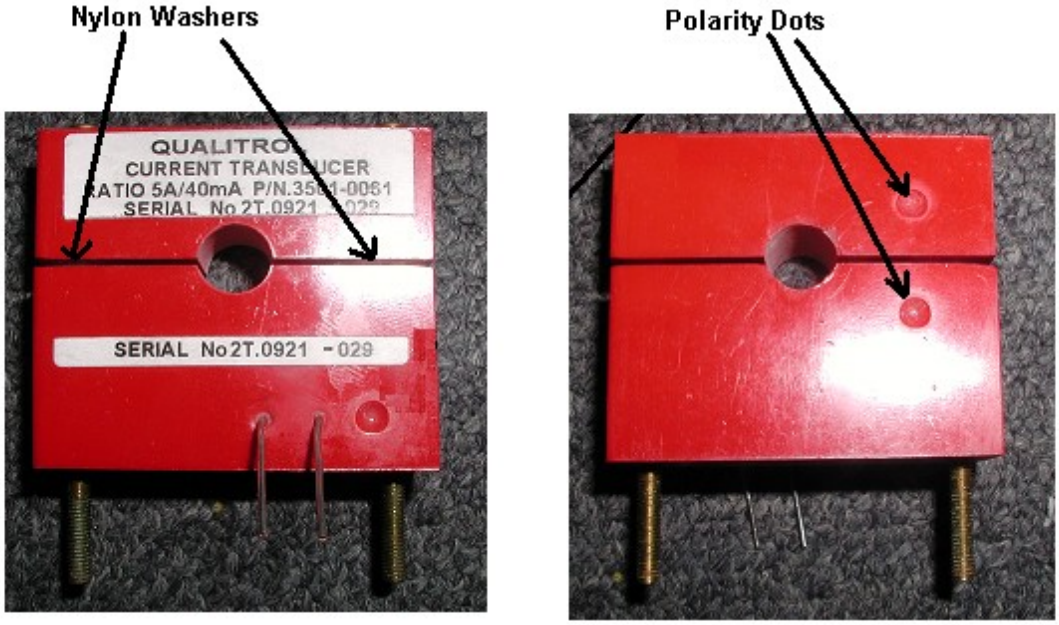


Figure 10 - Inductive Couplers with polarity dots

It is important to match the polarity dots of the two sections of the linear coupler when fitting as shown.

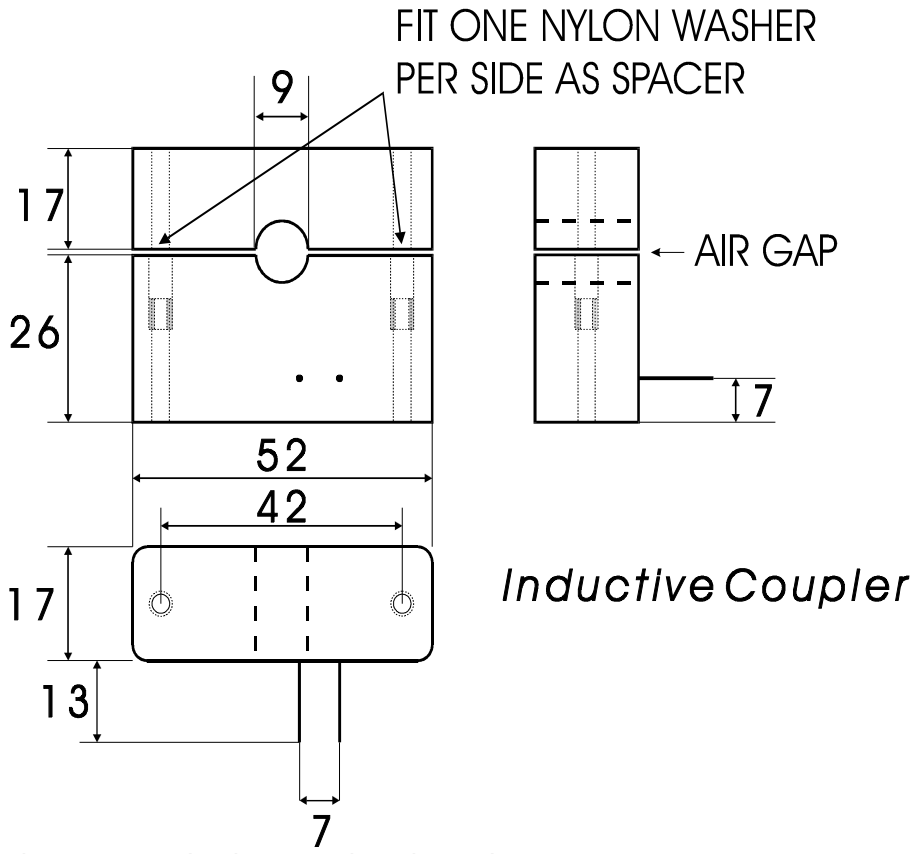


Figure 11 - Inductive Coupler Dimensions

The inductive couplers should have an ‘air gap’ between the two halves when installed. Nylon washers are provided for this purpose. See Figure 11 for positional detail of the nylon washers

The linear couplers need to be fitted one on each phase around the secondary wiring from the protection current transformers associated with the line being monitored. They need to be fitted consistently facing the same direction on each phase to meet the direction (polarity) convention. It has been accepted that the positive direction of view is towards the line (see section 4.7). They should be fitted to the connecting leads of a set of protection current transformers which are dedicated to feeding a protection relay (digital relays result in better signals than electromechanical relays). See figure 12. If this is not possible, please consult QUALITROL for advice.

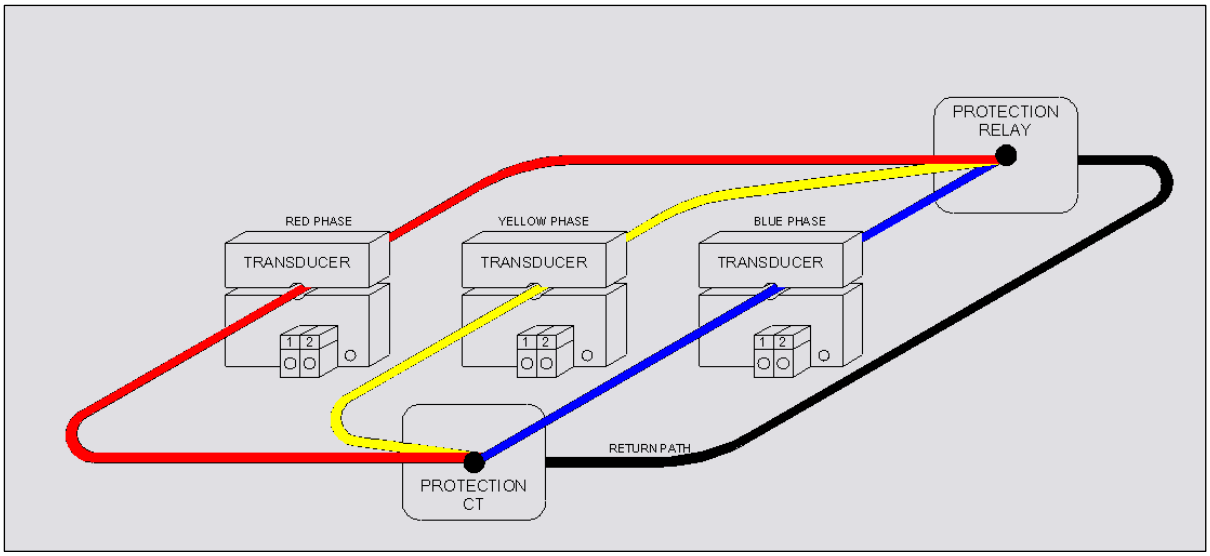


Figure 12 - Inductive Coupler connection

The connecting cable between the linear couplers and the TWS should either be:
Three individual cables (one for each phase). Each cable should be a screened twisted pair cable. Conductors should be of copper and at least 7 strand 0.25 mm (for mechanical strength in a substation environment). Insulation should be polythene or polypropylene for low loss.

One cable containing 3 individually screened twisted pairs. Conductors should be copper and at least 7 strand 0.25 mm for mechanical strength. Insulation should be polythene or polypropylene for low loss.

The three core cable is preferred.

Terminal blocks are provided to fit the cable to the linear coupler secondary connections. Alternatively the cable can be soldered directly onto these connections and a low temperature heat shrink sleeve fitted to match the cable size being used. The cable screens should be insulated and left open circuit.

The other end of the cable is connected to the TWS analogue inputs marked “A”, “B” and “C” as shown below in Figure 13. Note that polarity is marked on terminal block. The ‘+’ at the line module needs to be connected to the terminal adjacent to the ‘polarity dot’ on the linear coupler (see figure 10).

The cable screens must be connected to one of the earth terminals on the TWS line module terminal blocks.

The cable(s) at the TWS should be clearly labelled with the line name. A label should be fitted identifying feeder names with line module numbers.

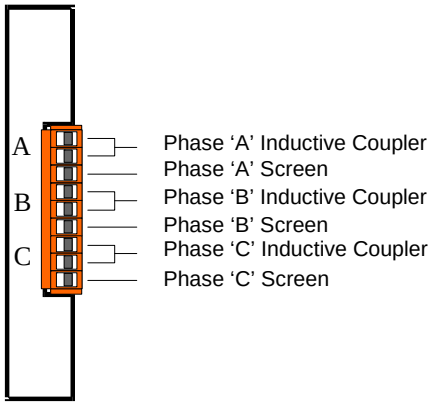


Figure 13 - View of physical analogue channel connections

The length of cable between the inductive couplers and the TWS should be no longer than 25m. Contact QUALITROL if longer cable runs are required. The screen is earthed at the TWS end only. Observe the polarity: dot on linear coupler to + on TWS

4.7. Inductive Coupler Polarity

Care should be taken to maintain polarities so that the phasing of connections from the current transformers to TWS is known. The split core inductive couplers are installed without circuit outages. The inductive couplers allow travelling waves to be recorded but attenuate the 50/60Hz components.

The convention is to install inductive couplers looking into the line (as described in section 4.7). Figure 14 show an "in zone" fault. The inductive couplers in this example are installed in such a way that they are looking into the line. The resulting transients recorded by the TWSs at either end of the line (shown in green) then have the same polarity.

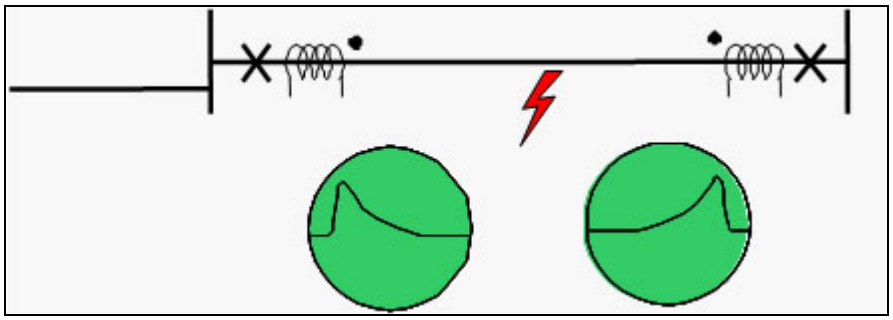


Figure 14 - Fault occurring on the line being monitored by the TWS

Figure 15 shows an "out of zone" fault again with both the inductive couplers installed at each end of the line looking into the line. The resulting transients recorded by the TWS this time have opposite polarities.

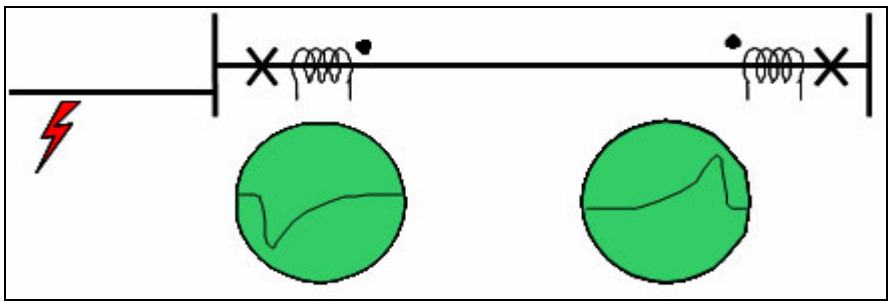


Figure 15 - Fault occurring outside the line being monitored

4.8. Optional Mounting Board for CTs

If requested the CTs can be attached to an optional mounting board rather than the usual loose installation. Figure 16a and 16b shows how the CTs are fastened to the mounting board. Note if the CTs are installed in this manner then it will be necessary to open circuit the CT wiring to allow connection to the screw terminals on board located at P2

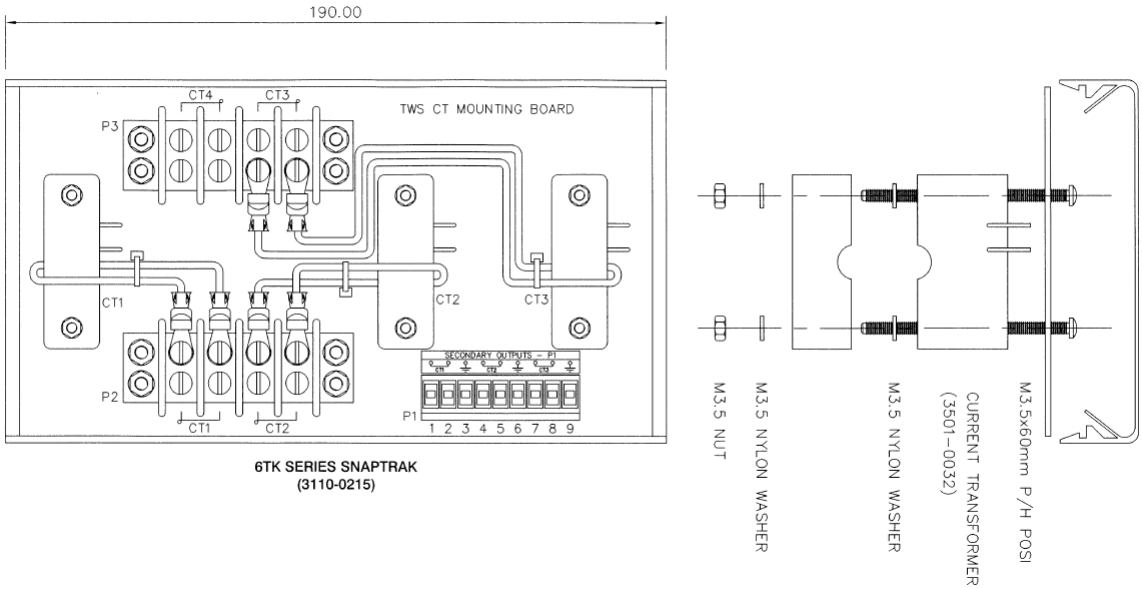


Figure 16-a - Optional CT Mounting Board

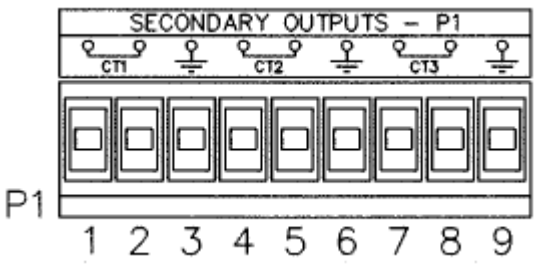


Figure 16-b - P1 Secondary outputs

4.9. The GPS Antenna

Link the GPS antenna to the connection on the rear of the TWS.

There are a number of GPS satellites in different orbits, and at any time, the antenna must be able to lock on to four of them for accurate time synchronisation. This means that the requirements for a GPS antenna are very different from that of a satellite antenna for domestic use which is a directional antenna looking at one satellite in a geostationary orbit.

The GPS antenna therefore needs to be installed in a position where it can see as much as possible of the sky. See figure 17 for an antenna placement guide. The antenna is provided with a 10m connecting cable terminated in the correct BNC plug to fit the GPS antenna socket on the rear panel. The antenna is mounted on a 25mm mast and should be placed with as much visibility to open sky as possible. If necessary, the cable can be extended with up to a maximum of 30m of RG6 cable. Longer cable runs require in-line amplification. For further detail, please contact QUALITROL.

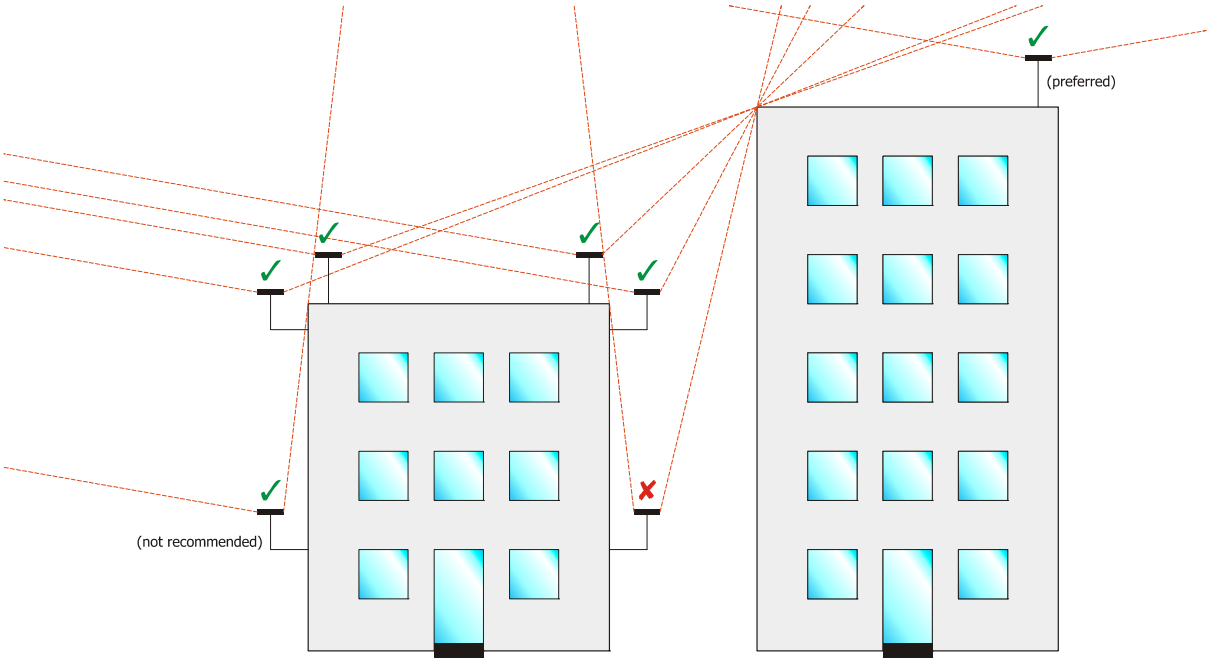


Figure 17 - GPS Antenna placement guidelines

Figure 18 - GPS Antenna

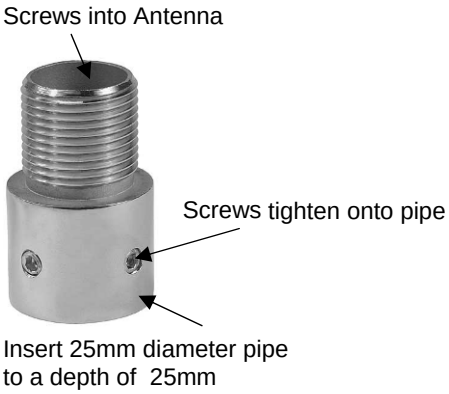
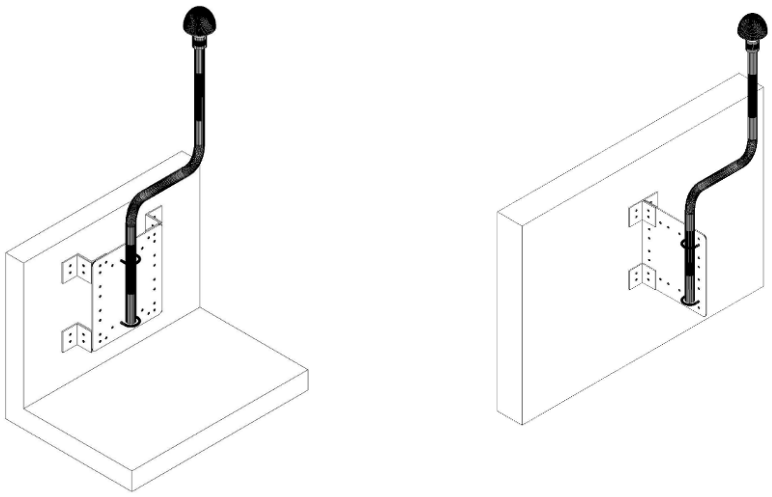


Figure 19 - Adapter for GPS Antenna



Mounting Plate 23.2 cm x 26cm. Mast height 65cm without antenna adapter fitted.

Figure 20 - Optional Antenna Mounting Kit

4.10. Alarms

The CPU board provides isolated contacts, which provide four alarms via the substation alarm system, or for other purposes.
The contacts are isolated to a 6kV test voltage between coil and contacts, and 1.5kV between contacts. The contacts are rated to switch:

- Currents up to 8A at 250V ac
- Currents up to 8A at 30V dc in a non inductive circuit
- Currents up to 250mA up to 250V dc in a non inductive circuit

The matching plug is supplied with the unit.
The connections of the 4 contacts are shown in Fig 20.
A closed contact denotes an alarm condition.

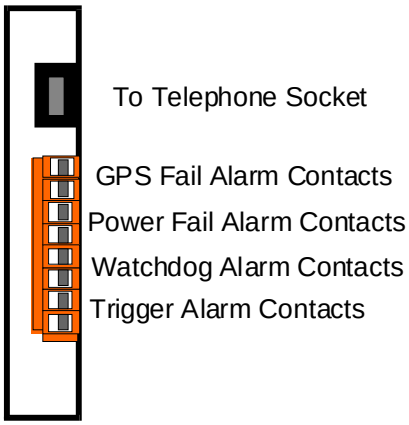


Figure 20 - Alarms and Modem Interface

There are many travelling waves on a transmission system that are not generated by system faults but can cause a TWS to trigger. Not all the events signalled by the Trigger Alarm contact indicate fault activity

5. TWS Commissioning

5.1. Commissioning Steps

After a TWS has been installed there are a number of commissioning steps required to ensure the TWS is primed and ready to record faults. The following steps should be performed on the TWS following the physical installation steps taken in section 4 of this manual

- Visual inspection
- Initial switch on
- Checking TWS LED status
- Using TWS web page to edit config.tws file
- Using TWS web page to edit TWS IP address.
- Testing Dial up connection

5.2. Visual Inspection

Open the TWS front panel by releasing the quick release clips at the top and lowering it down on the bottom hinges.

Check that all the circuit boards and connectors are in place and have not become dislodged in transit.

5.3. Initial Switch On

Having installed all the auxiliary equipment, and become familiar with the positions of the various indications and controls commissioning can begin.

Check the voltage is within the power supply limits and apply power to the TWS.

The Power Status LED should show green indicating that the supply voltage is on.

If the Power Status LED does not show green then:

(a) Check that the voltage supply which feeds the TWS is switched on.
(b) Check that the correct voltage is available on the supply terminals of TWS.

If none of these checks reveal any problems contact QUALITROL for further advice.

5.4. TWS Status LEDs

On the TWS front panel there is a set of three indicator LEDs as shown in Fig 21.

- The top one labeled “Power” indicates that the power supply is on. It is linked to the alarm contacts available on the back panel. When the light is out the corresponding alarm contact at the back of the instrument is closed.
- The middle one labeled “GPS Locked”. When the light is on it indicates that the internal GPS Module has acquired satellites (or LOCK). When the light is out the corresponding alarm contact at the back of the instrument is closed.
- The bottom one labeled “Watchdog” is an alarm, which indicates that TWS software in the TWS has failed. When it is ON, the corresponding alarm contact on the back of the instrument is closed.

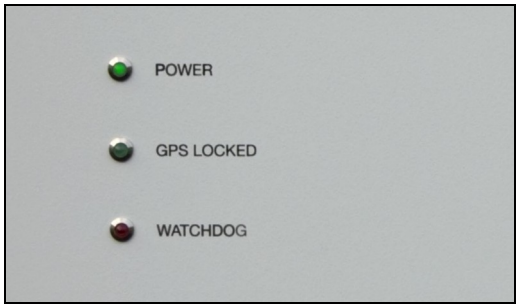


Figure 21 TWS Indicator LEDs

The Watchdog will come on for a short time (several minutes) on power up. This is normal behavior

The TWS also has a Dongle LED. It can be found on the rear panel of the unit as shown in figure 22 below. This LED indicates that the TWS is in a healthy state. When the TWS software is running and the unit is in a healthy state the Dongle LED will flash at a rate of once every second. If the TWS software is not running the Dongle LED will be extinguished.

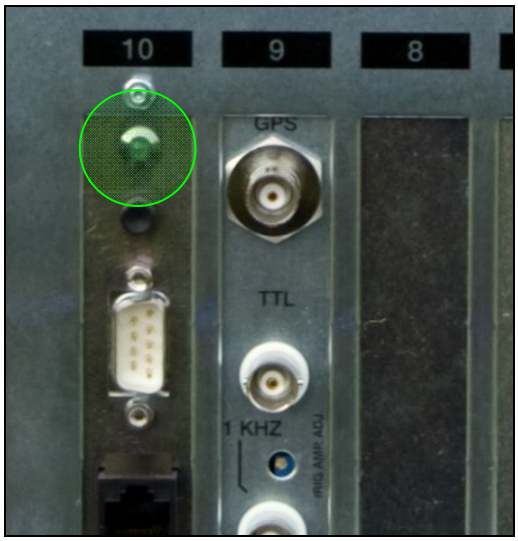
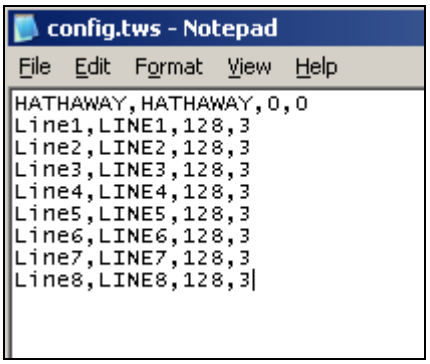


Figure 22 - Dongle LED

It will take several minutes after power up (similar to the watchdog) for the dongle LED to start flashing. This is normal behaviour.

5.5. The “config.tws” file.

Each TWS MkVI unit contains a file called “config.tws”. An example of the default “config.tws” file is shown below left along with the file format below right. It is necessary to synchronise the names given to the line modules in the TWSBase2000 software with the names given to the line modules in the “config.tws” file. This section describes the correlation between the TWSBase2000 software and the “config.tws”.



File format

Sub-Station Name, TWS Name, 0, 0

Title, Subdirectory, Gain, Sampling Frequency

Title, Subdirectory, Gain, Sampling Frequency

Title, Subdirectory, Gain, Sampling Frequency

Title, Subdirectory, Gain, Sampling Frequency

Title, Subdirectory, Gain, Sampling Frequency

Title, Subdirectory, Gain, Sampling Frequency

Title, Subdirectory, Gain, Sampling Frequency

Title, Subdirectory, Gain, Sampling Frequency

5.6. Description of “config.tws” file contents.

Sub-Station Name This is the sub-station name and can be a maximum of 25 characters.

TWS Name This is the TWS Name and can be a maximum of 8 characters.

0,0 Should not be changed by the user, but must be present.

Title This contains text that was more widely used by the older MkII, MkIII and MkIV TWS’s. This parameter is used in the MkVI TWS for the diagnostic file. The title Line1, Line2 etc should be present but does not need to be altered by the user.

Sub-directory In earlier firmware versions this contained the name of the sub-directory on the TWS flash memory in which the instrument would store its results. It is only used now as a display field in the diagnostic file. It can be used as a secondary label if required. It must be between 1 and 15 characters long.

Gain is the gain setting for the amplifier in the line modules. It must be a number between 0 and 255. “0” is no gain and means that the module is effectively turned off. “255” is maximum possible gain and corresponds to 0.2 Volts Full Scale Deflection (FSD). The default value is 128.

Sampling Frequency is the sampling frequency of the analogue to digital converter module. It must be set to 3 to match the sampling rate of 1.25 MHz.

5.7. TWS Webpage Configuration Tool

On TWS MkVI outstations running software versions 8.04 or later an additional feature has been added to enable configuration and management of the TWS by web page.
To run the TWS web page simply connect a PC to the TWS via one of the following ways:

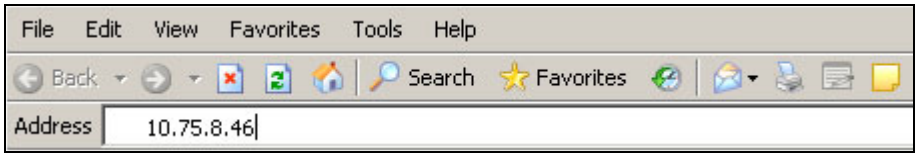
- Connect the PC via a **cross over** Ethernet cable or through two **straight** Ethernet cables via a **hub**.
- Set up a dial up modem connection via Windows PPP (see TWSbase 2000 manual)

The default IP address for a TWS is 10.75.8.**46**. Therefore it will be necessary to set the IP address of your PC to be on the same subnet as the TWS. An example PC IP address setting would be: -

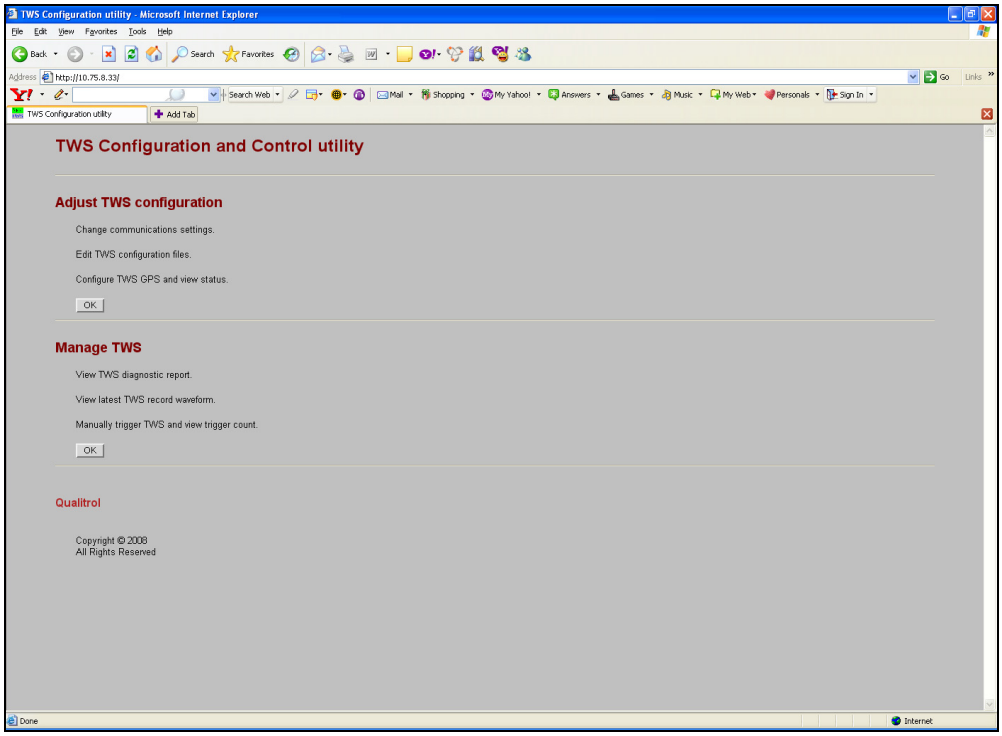
PC IP address = 10.75.8.**47**

PC Subnet mask = 255.255.255.0

Once your PC IP address has been configured, open internet explorer and type in the IP address of the TWS in the “address” bar followed by clicking “go”.

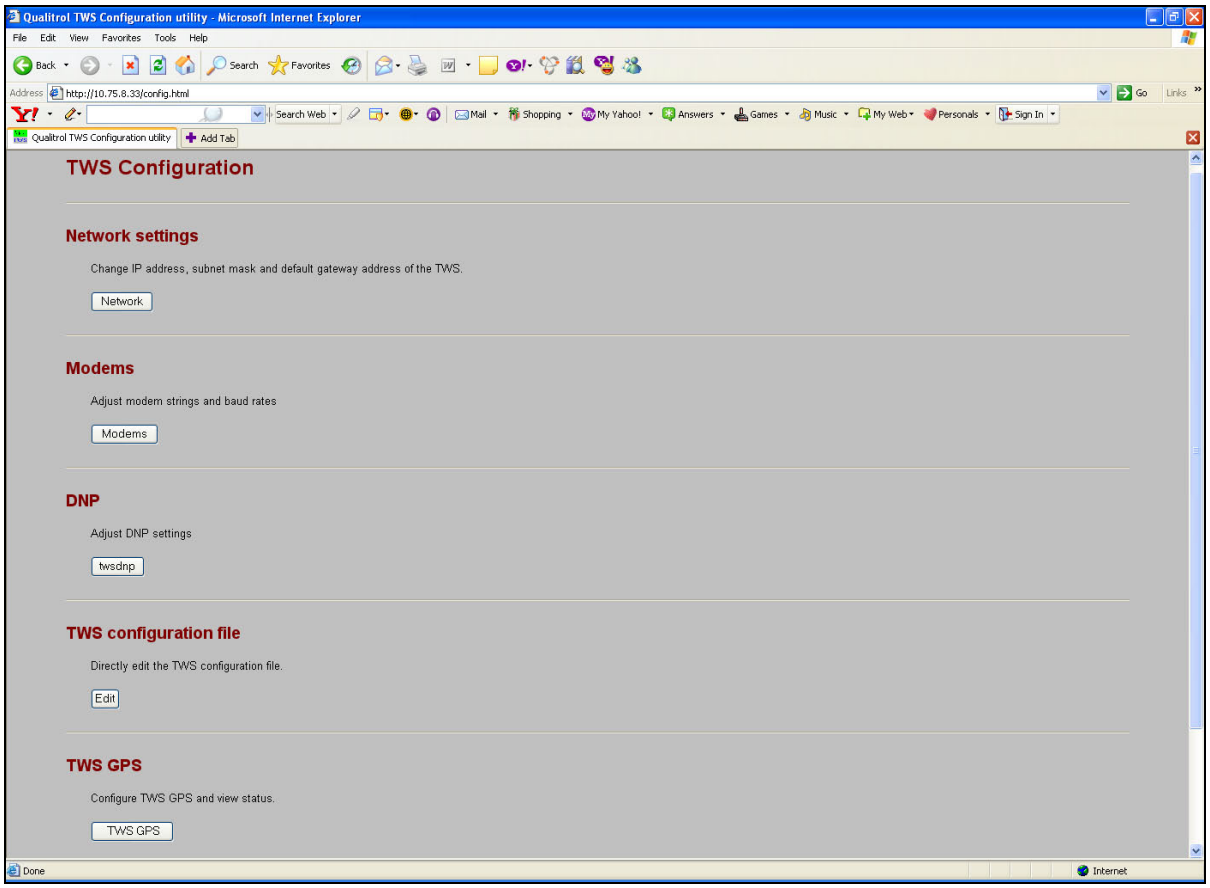


A username and password prompt should appear. Type in the username **tws** and the password **hathaway** and click ok. The following screen should appear.



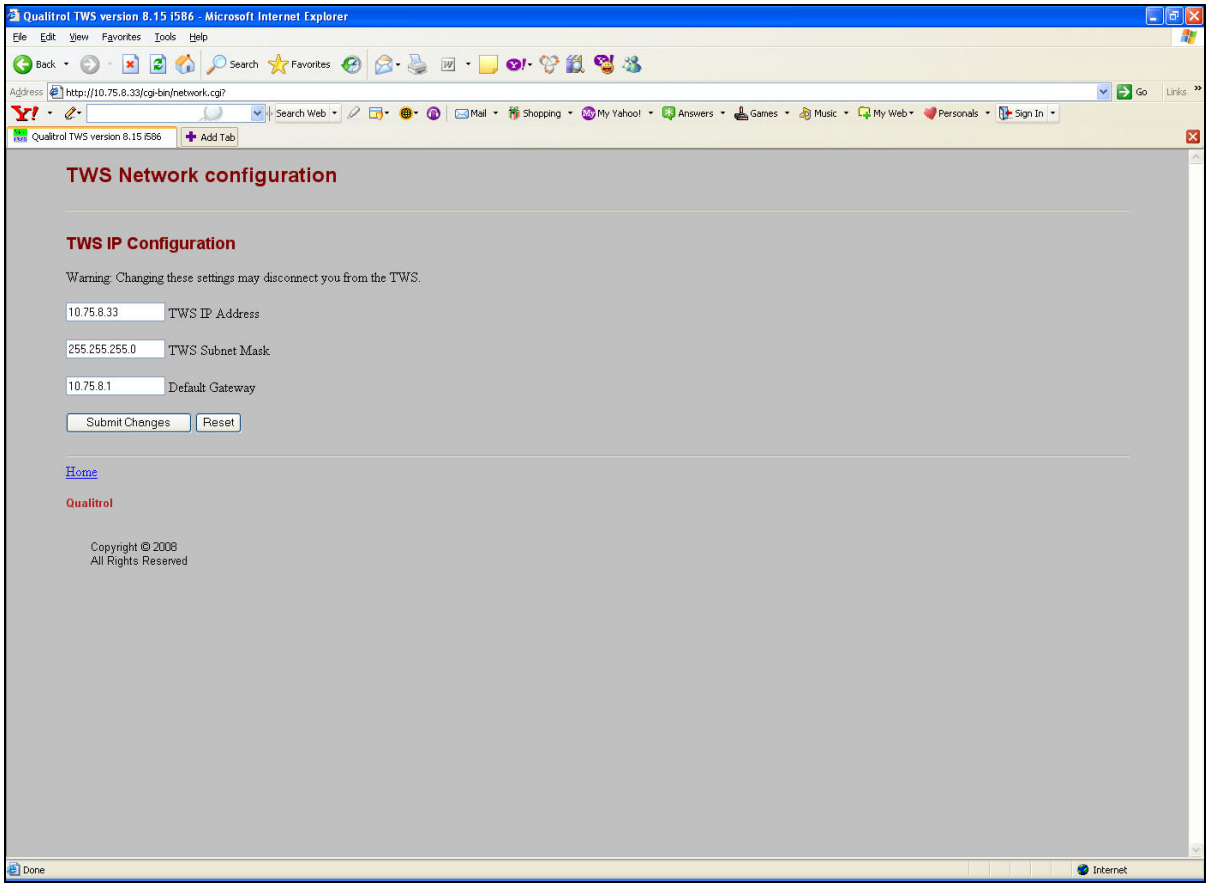
5.7.1. Adjust TWS Configuration

When the **OK** button for **Adjust TWS configuration** is clicked the web page below will be displayed. This page has five options. With this we can change the network settings, adjust modem strings and baud settings, adjust DNP settings, edit the configuration file and configure the TWS GPS.

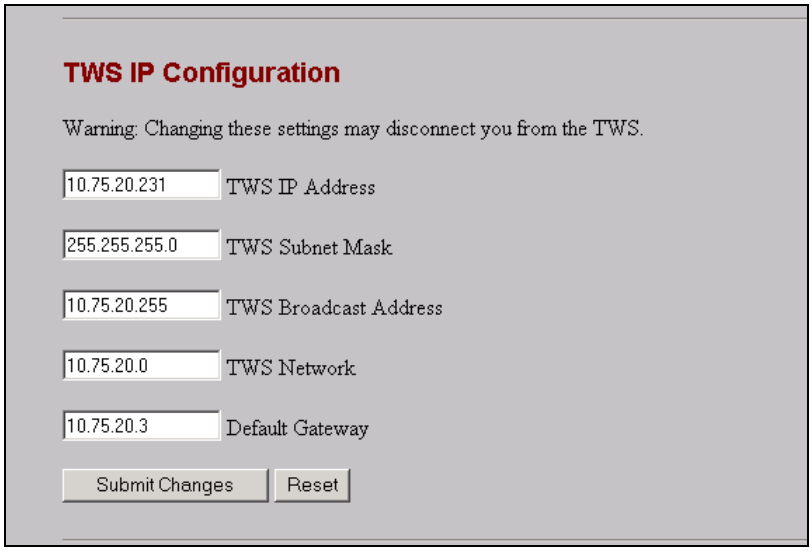


Network Settings

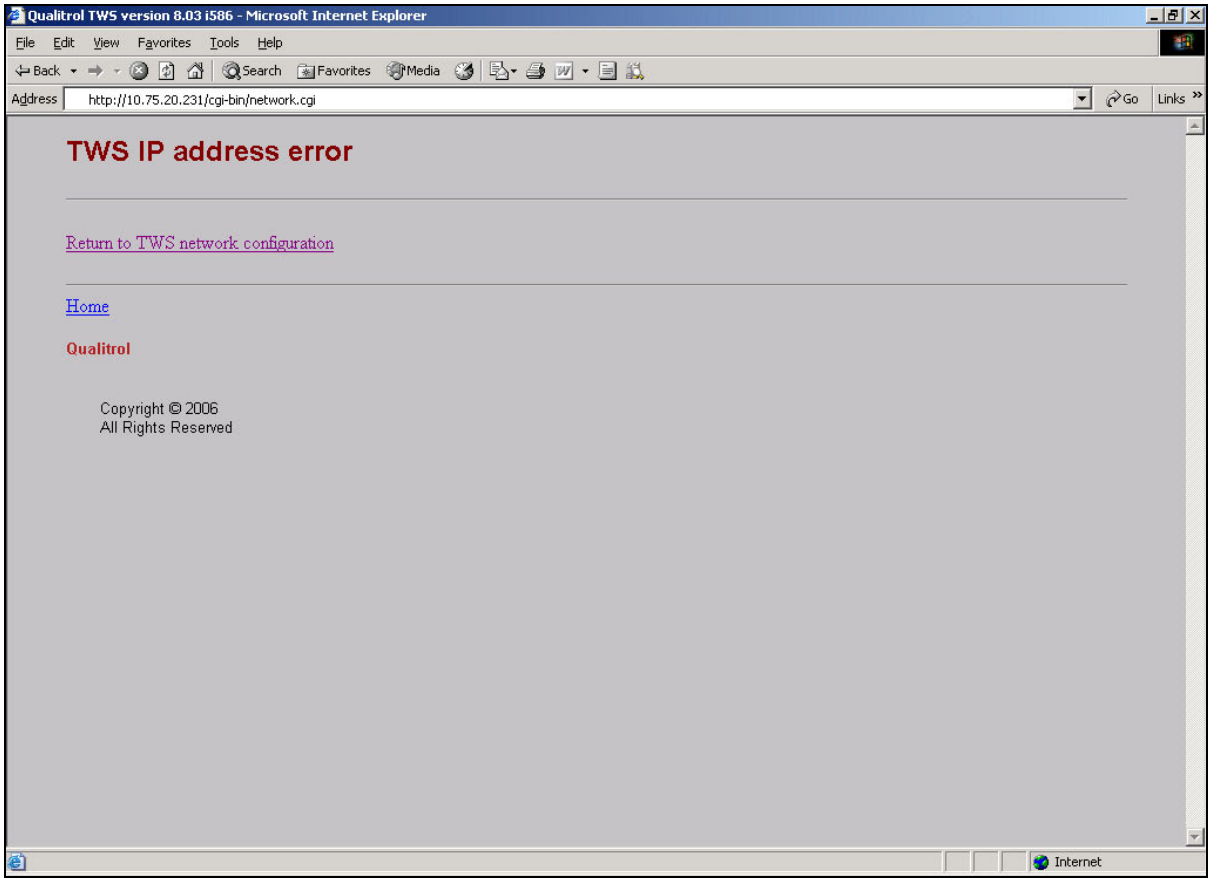
On selecting **Network**, the following page is displayed. The current network settings are shown. These may be edited to new values which are saved and come into effect when **Submit Changes** is selected. **Reset** will revert the settings back to the original values when the page was first displayed.



If the TWS broadcast address or network has been set in the TWS Linux network configuration files, these items will also be editable in the TWS Network configuration page as shown below.



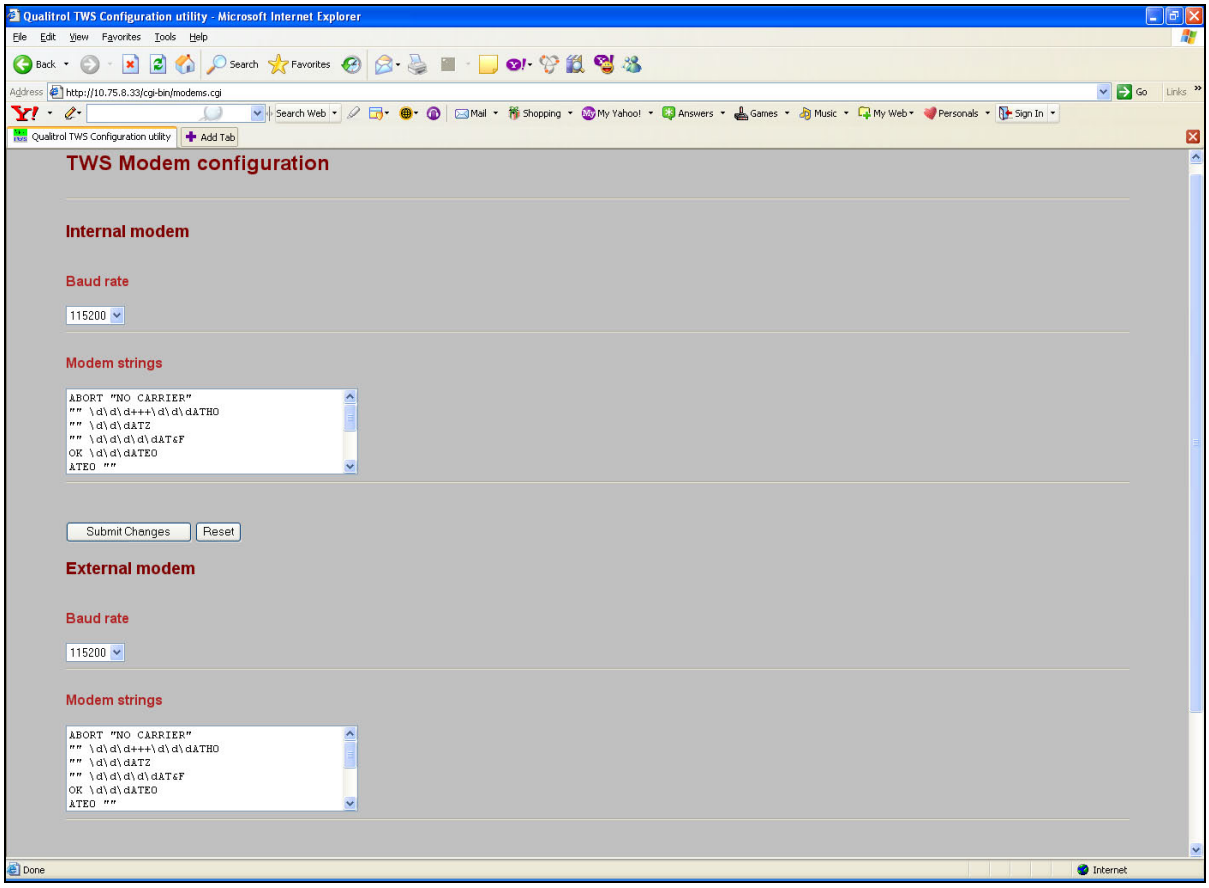
Network addresses are accepted in dotted quad form. If any of the addresses are not in this form, e.g. out of range values or non digit characters, a message similar to below will be displayed and any changes will not come into effect.



Connection to the TWS will be lost once changes to the IP addressing have been submitted. It will be necessary to re-connect using the new IP details to continue the TWS setup process.

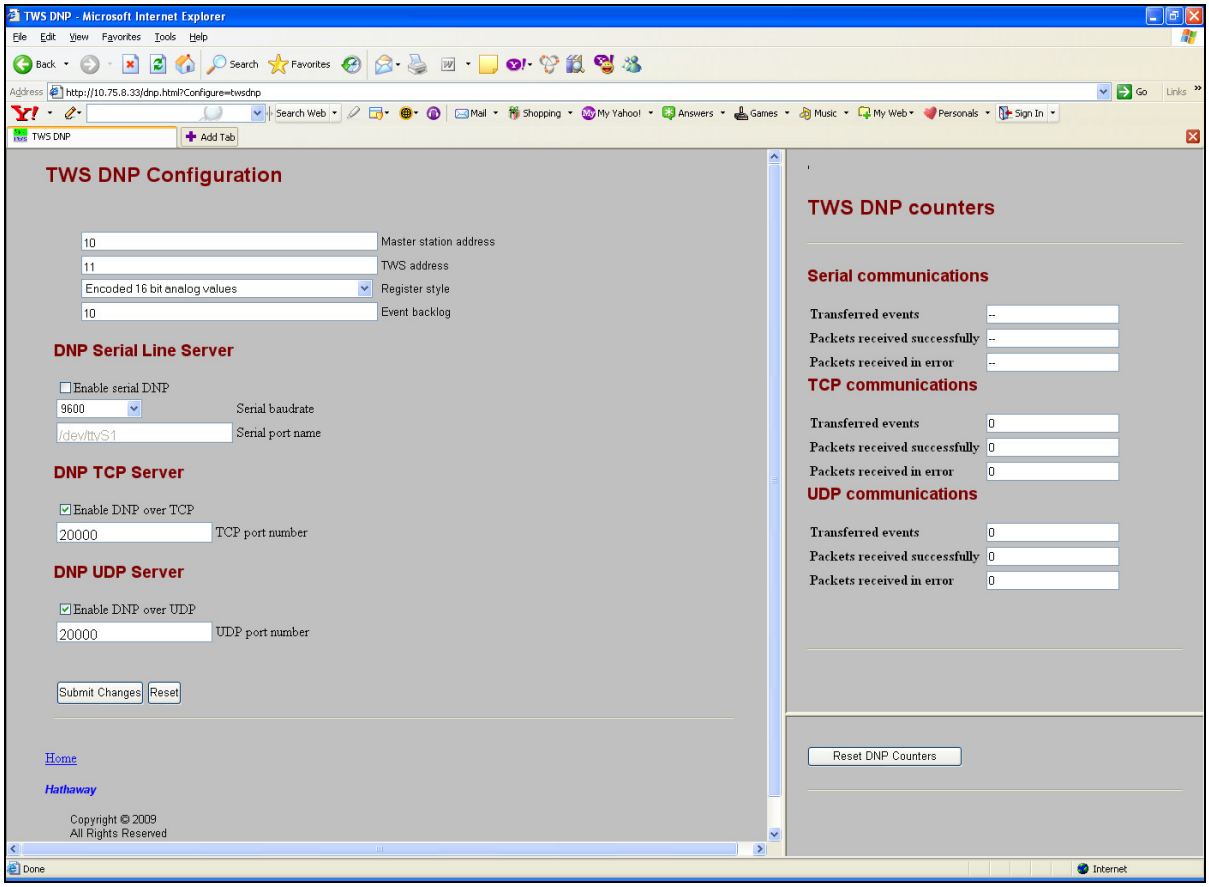
Modems

On selecting **Modems** the following page is displayed. The baud rate and modem initialisation string of the internal and external modem may be altered here, and the changes will come into effect once the 'submit changes' button is pressed. Pressing 'Reset' before 'submit changes' will restore the initialisation string to it's initial setting. In practice it should not be necessary to alter the internal modem settings. External modem settings would be updated if it was planned to use an external modem, such as a GSM modem.



DNP Configuration

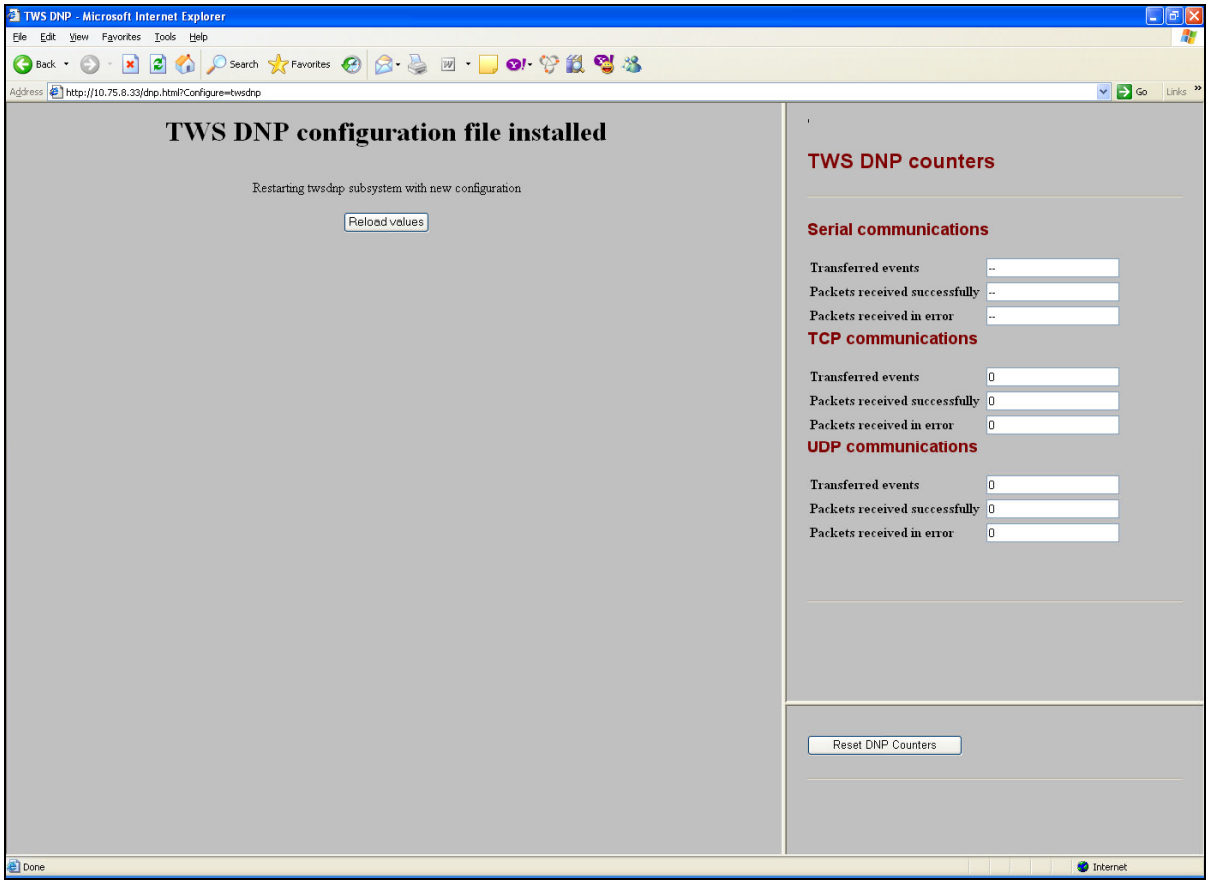
On selecting **DNP** the following page is displayed. It is divided into three sections. The section at the left side allows the user to change the DNP configuration, the section on the upper right displays a DNP transaction counters, and the button on the lower right resets all the DNP transaction counters to zero.



The master station address and the TWS address associated with the DNP protocol may be altered in the TWS DNP configuration section. A selection between a 16 bit encoding and 32 encoding register style may be made. The number of buffered TWS triggers which are available to be transferred may be set in the ‘Event backlog’ field.

The three types of DNP communications – serial, UDP and TCP may be enabled or disabled in this section. The serial baud rate is configurable here. Note the serial port at the rear of the TWS may be used for either serial DNP or for an external modem, and if serial DNP is enabled then the external modem functionality is disabled. The serial port name can be ignored as it cannot be altered. The TCP and UDP port numbers may also be re-configured.

Changes made in this section will only come into effect after the **Submit Changes** button is pressed. Pressing **Reset** before ‘submit changes’ will restore the DNP settings to their initial setting. Once the **Submit Changes** button is pressed the following screen will be displayed.



The ‘Reload values’ button should now be pressed.

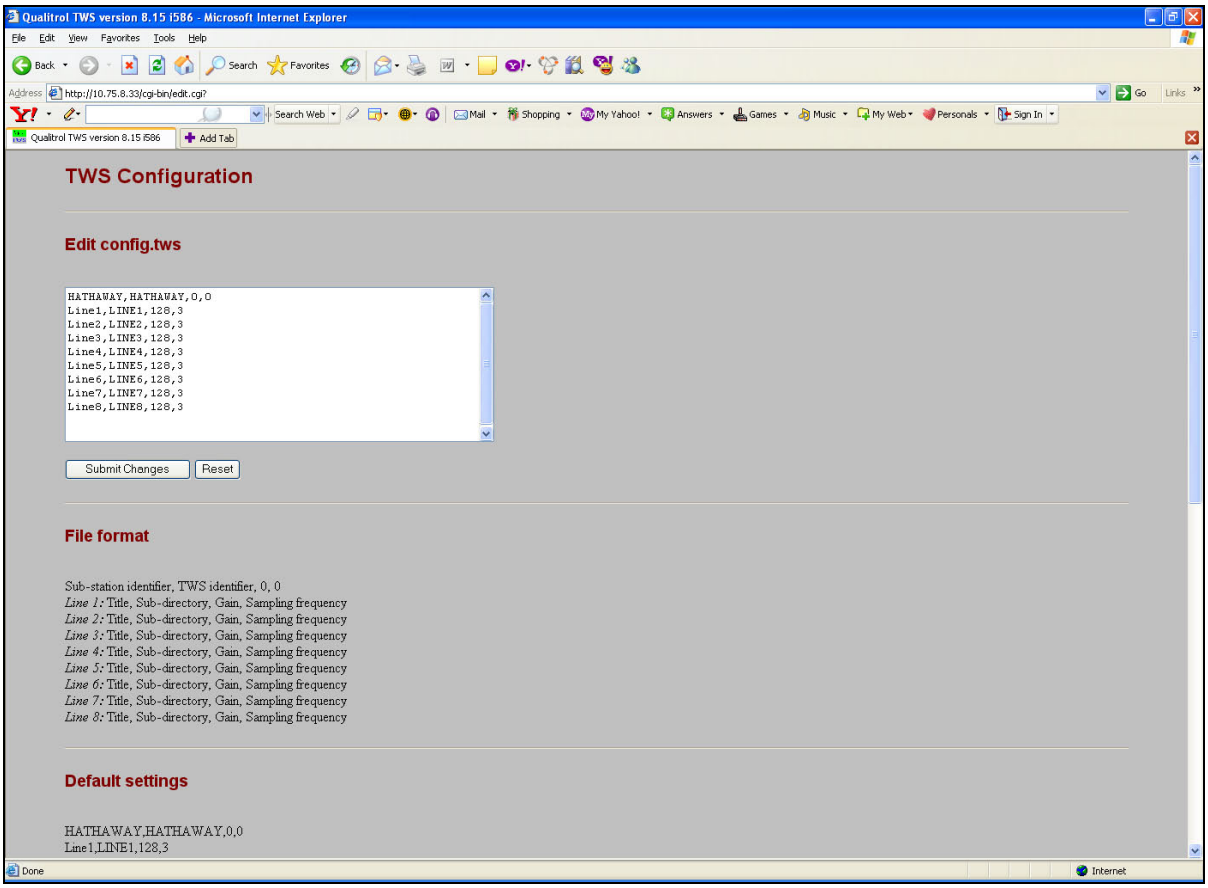
The TWS DNP counters will update in real time, as DNP transactions take place, and provide a method of monitoring the three communication types. This section is for display only.

Pressing the **Reset DNP Counters** button will set all counters to display zero.

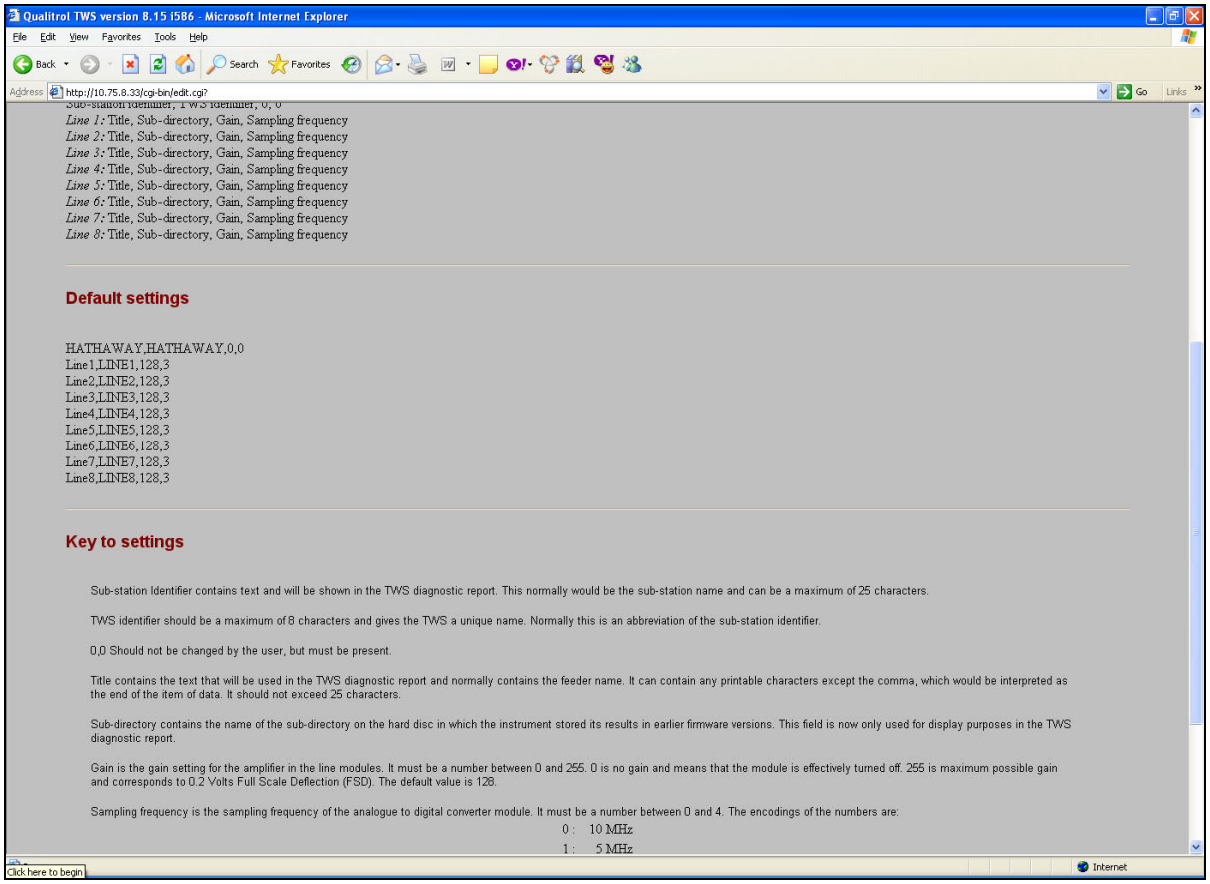
See Appendix D for details of the DNP implementation in the TWS.

TWS Configuration

The following page is displayed when the Edit button is selected from the TWS Configuration web page. The contents of the TWS configuration file “config.tws” are shown. The file entries may be edited to new values which are saved and come into effect when ‘Submit Changes’ is selected. ‘Reset’ will revert the settings back to the original values when the page was first displayed.



Scrolling down the TWS Configuration web page displays the fixed text below detailing the file format and the default settings of “config.tws” as described previously in this manual. An explanation is also given of each parameter.

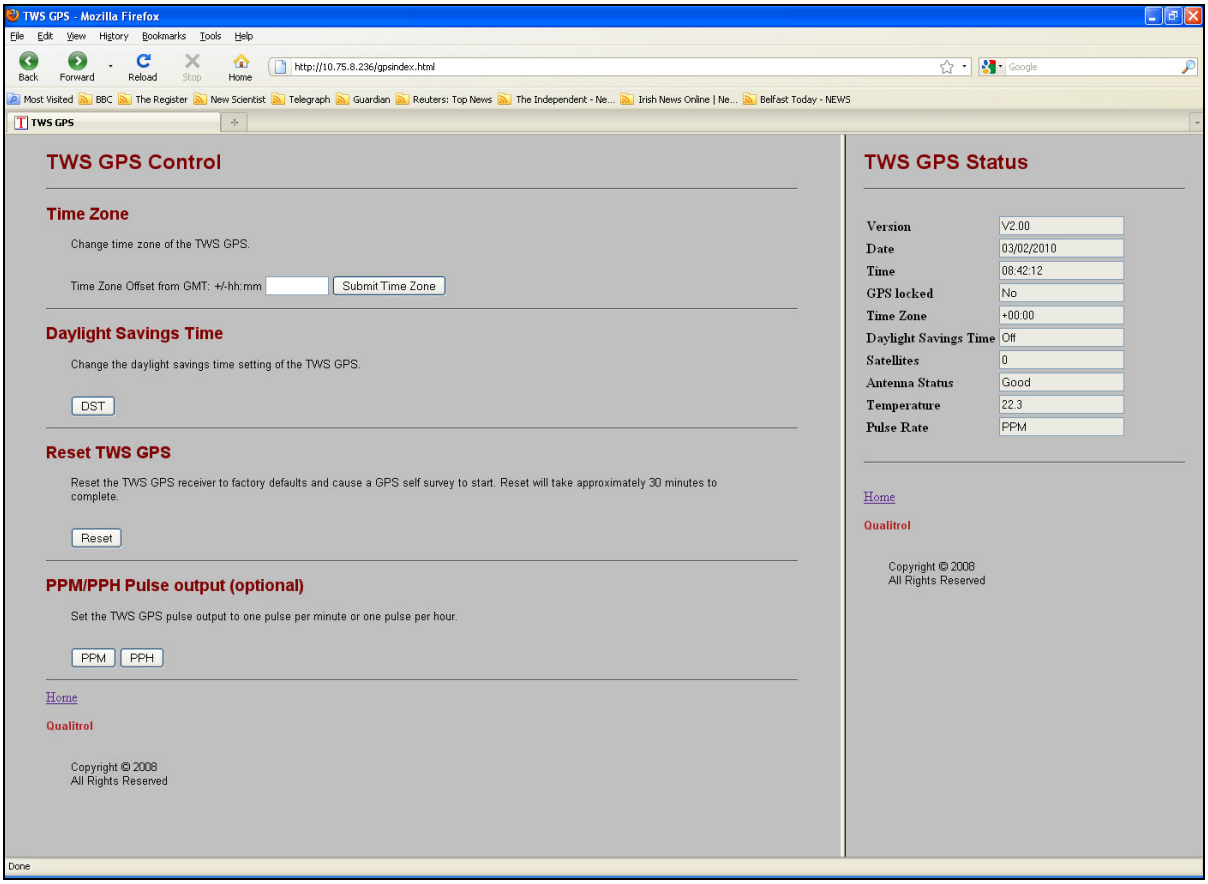

Qualitrol TWS version 8.15 i586 - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites
Address http://10.75.8.33/cgi-bin/edit.cgi?
Go Links
Line 1: Title, Sub-directory, Gain, Sampling frequency
Line 2: Title, Sub-directory, Gain, Sampling frequency
Line 3: Title, Sub-directory, Gain, Sampling frequency
Line 4: Title, Sub-directory, Gain, Sampling frequency
Line 5: Title, Sub-directory, Gain, Sampling frequency
Line 6: Title, Sub-directory, Gain, Sampling frequency
Line 7: Title, Sub-directory, Gain, Sampling frequency
Line 8: Title, Sub-directory, Gain, Sampling frequency
Default settings
HATHAWAY,HATHAWAY,0,0
Line1,LINE1,128,3
Line2,LINE2,128,3
Line3,LINE3,128,3
Line4,LINE4,128,3
Line5,LINE5,128,3
Line6,LINE6,128,3
Line7,LINE7,128,3
Line8,LINE8,128,3
Key to settings
Sub-station Identifier contains text and will be shown in the TWS diagnostic report. This normally would be the sub-station name and can be a maximum of 25 characters.
TWS identifier should be a maximum of 8 characters and gives the TWS a unique name. Normally this is an abbreviation of the sub-station identifier.
0,0 Should not be changed by the user, but must be present.
Title contains the text that will be used in the TWS diagnostic report and normally contains the feeder name. It can contain any printable characters except the comma, which would be interpreted as the end of the item of data. It should not exceed 25 characters.
Sub-directory contains the name of the sub-directory on the hard disc in which the instrument stored its results in earlier firmware versions. This field is now only used for display purposes in the TWS diagnostic report.
Gain is the gain setting for the amplifier in the line modules. It must be a number between 0 and 255. 0 is no gain and means that the module is effectively turned off. 255 is maximum possible gain and corresponds to 0.2 Volts Full Scale Deflection (FSD). The default value is 128.
Sampling frequency is the sampling frequency of the analogue to digital converter module. It must be a number between 0 and 4. The encodings of the numbers are:
0 : 10 MHz
1 : 5 MHz
Click here to begin
Internet

TWS GPS

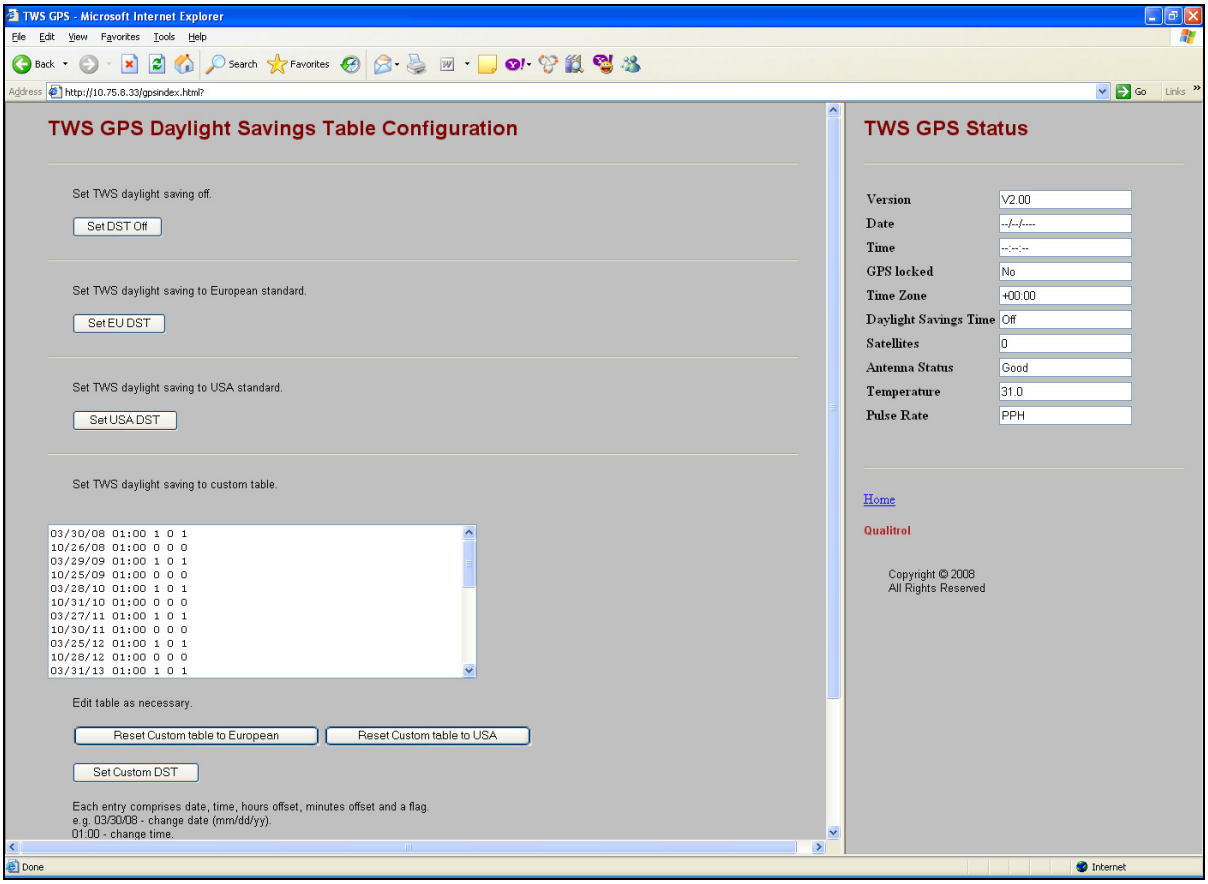
The page below will be shown when selecting TWS GPS.

The GPS status gives details of the GPS current time and settings. In this instance the antenna was unplugged so GPS lock has been lost and the number of satellites tracked is zero. It is necessary to track 4 satellites for a good GPS lock.

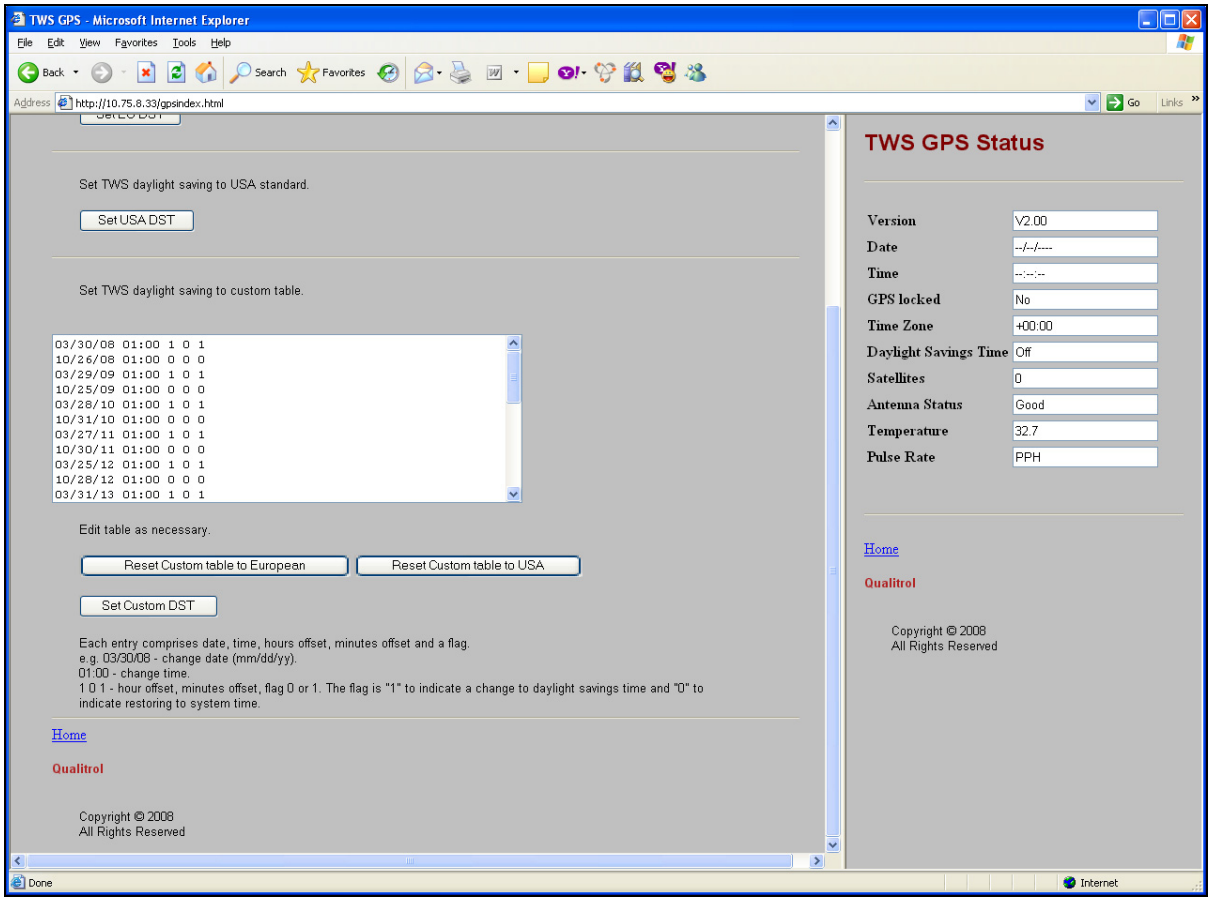
The Time Zone and Daylight Settings can also be changed. For example, if the time is to be changed to GMT +5, simply type +5 and click Submit Time Zone.



Daylight Saving can be switched on and off by clicking Set DST daylight saving off. The screen shown below has a number of options for European standard DST and USA standard DST. These can be selected by simply clicking Set EU/USA DST.


TWS GPS - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites
Address http://10.75.8.33/gpsindex.html?
Go Links
TWS GPS Daylight Savings Table Configuration
Set TWS daylight saving off.
Set DST Off
Set TWS daylight saving to European standard.
Set EU DST
Set TWS daylight saving to USA standard.
Set USA DST
Set TWS daylight saving to custom table.
03/30/08 01:00 1 0 1
10/26/08 01:00 0 0 0
03/29/09 01:00 1 0 1
10/25/09 01:00 0 0 0
03/28/10 01:00 1 0 1
10/31/10 01:00 0 0 0
03/27/11 01:00 1 0 1
10/30/11 01:00 0 0 0
03/25/12 01:00 1 0 1
10/28/12 01:00 0 0 0
03/31/13 01:00 1 0 1
Edit table as necessary.
Reset Custom table to European
Reset Custom table to USA
Set Custom DST
Each entry comprises date, time, hours offset, minutes offset and a flag.
e.g. 03/30/08 - change date (mm/dd/yy).
01:00 - change time.
TWS GPS Status
Version V2.00
Date --/--/----
Time --:--:--
GPS locked No
Time Zone +00:00
Daylight Savings Time Off
Satellites 0
Antenna Status Good
Temperature 31.0
Pulse Rate PPH
Home
Qualitrol
Copyright © 2008
All Rights Reserved
Done
Internet

Scrolling down the pane reveals extra buttons. A third option is to manually enter the DST settings, this can be done by clicking the Set Custom DST.


TWS GPS - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites
Address http://10.75.8.33/gpsindex.html
Go Links
Set TWS daylight saving to USA standard.
Set USA DST
Set TWS daylight saving to custom table.
03/30/08 01:00 1 0 1
10/26/08 01:00 0 0 0
03/29/09 01:00 1 0 1
10/25/09 01:00 0 0 0
03/28/10 01:00 1 0 1
10/31/10 01:00 0 0 0
03/27/11 01:00 1 0 1
10/30/11 01:00 0 0 0
03/25/12 01:00 1 0 1
10/28/12 01:00 0 0 0
03/31/13 01:00 1 0 1
Edit table as necessary.
Reset Custom table to European
Reset Custom table to USA
Set Custom DST
Each entry comprises date, time, hours offset, minutes offset and a flag.
e.g. 03/30/08 - change date (mm/dd/yy).
01:00 - change time.
1 0 1 - hour offset, minutes offset, flag 0 or 1. The flag is "1" to indicate a change to daylight savings time and "0" to indicate restoring to system time.
Home
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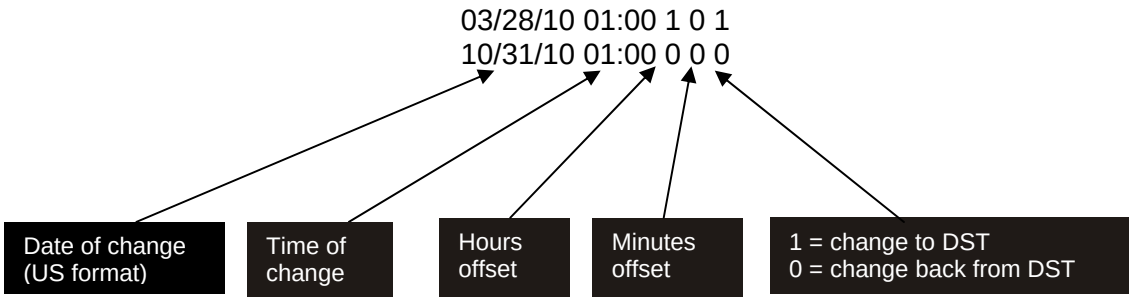
TWS GPS Status
Version V2.00
Date --/--/----
Time --:--:--
GPS locked No
Time Zone +00:00
Daylight Savings Time Off
Satellites 0
Antenna Status Good
Temperature 32.7
Pulse Rate PPH
Home
Qualitrol
Copyright © 2008
All Rights Reserved
Done
Internet

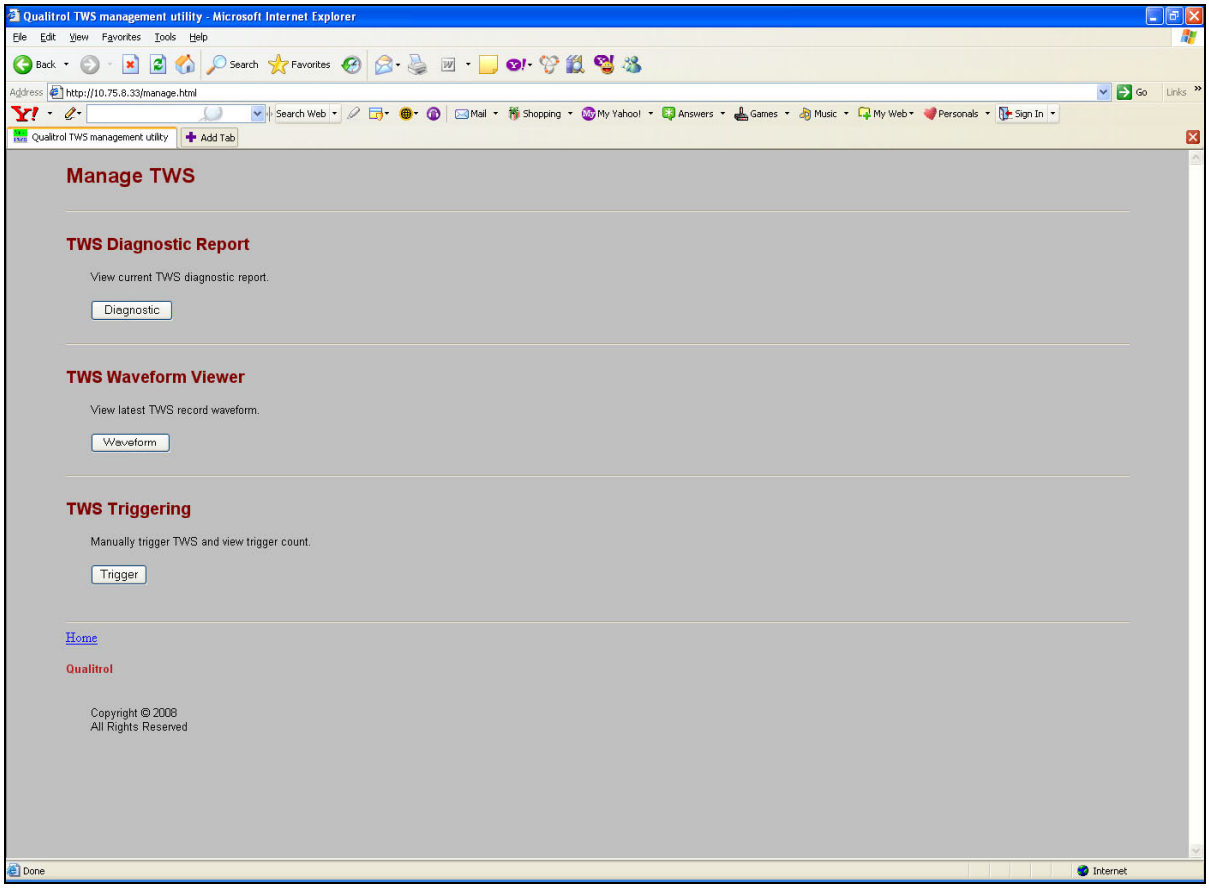
Click on Reset Custom table to European or Reset Custom table to USA to view the contents of either the EU or the USA daylight saving tables. Alternatively use one of these standards as a template for a custom table.

The format of the table is explained on the web page. In brief the table allows dates to be set over a 13 year period. The date and time of the changeover is specified along with the time offset in hours and minutes. The following is an example of a change to and a change back from daylight saving in 2010.


03/28/10 01:00 1 0 1
10/31/10 01:00 0 0 0
Date of change (US format)
Time of change
Hours offset
Minutes offset
1 = change to DST
0 = change back from DST

5.7.2. Manage TWS

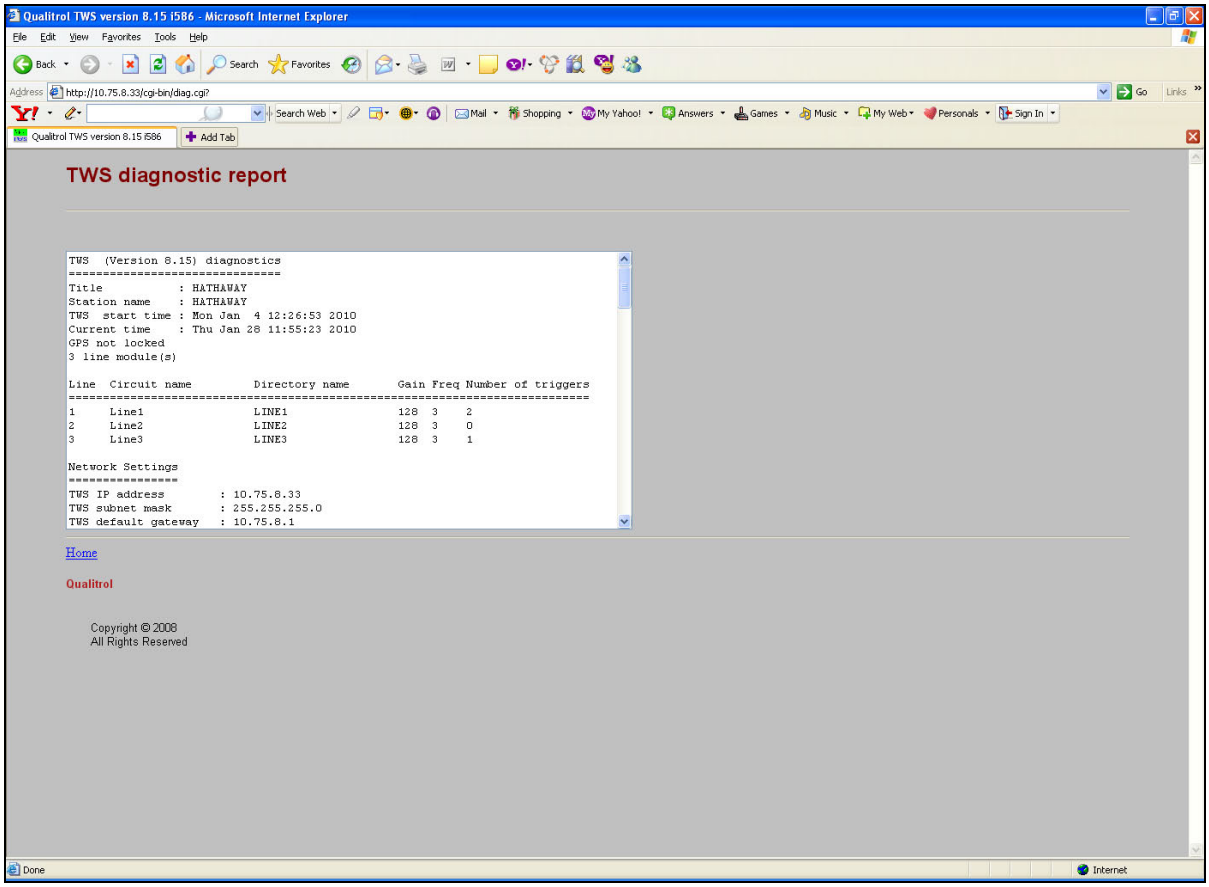
When the OK button for Manage TWS is selected three options become available, TWS Diagnostic Report, TWS Waveform Viewer and TWS Triggering. See below:



TWS Diagnostic Report

The TWS diagnostic report shown below is opened when the Diagnostic button is clicked on the main page.

Note there will a short delay before this page is visible. The scroll bar at the right side of the text window may be used to view all parts of the diagnostic report.


Qualitrol TWS version 8.15 i586 - Microsoft Internet Explorer
TWS diagnostic report
TWS (Version 8.15) diagnostics
Title : HATHAWAY
Station name : HATHAWAY
TWS start time : Mon Jan 4 12:26:53 2010
Current time : Thu Jan 28 11:55:23 2010
GPS not locked
3 line module(s)
Line Circuit name Directory name Gain Freq Number of triggers
1 Line1 LINE1 128 3 2
2 Line2 LINE2 128 3 0
3 Line3 LINE3 128 3 1
Network Settings
TWS IP address : 10.75.8.33
TWS subnet mask : 255.255.255.0
TWS default gateway : 10.75.8.1
Home
Qualitrol
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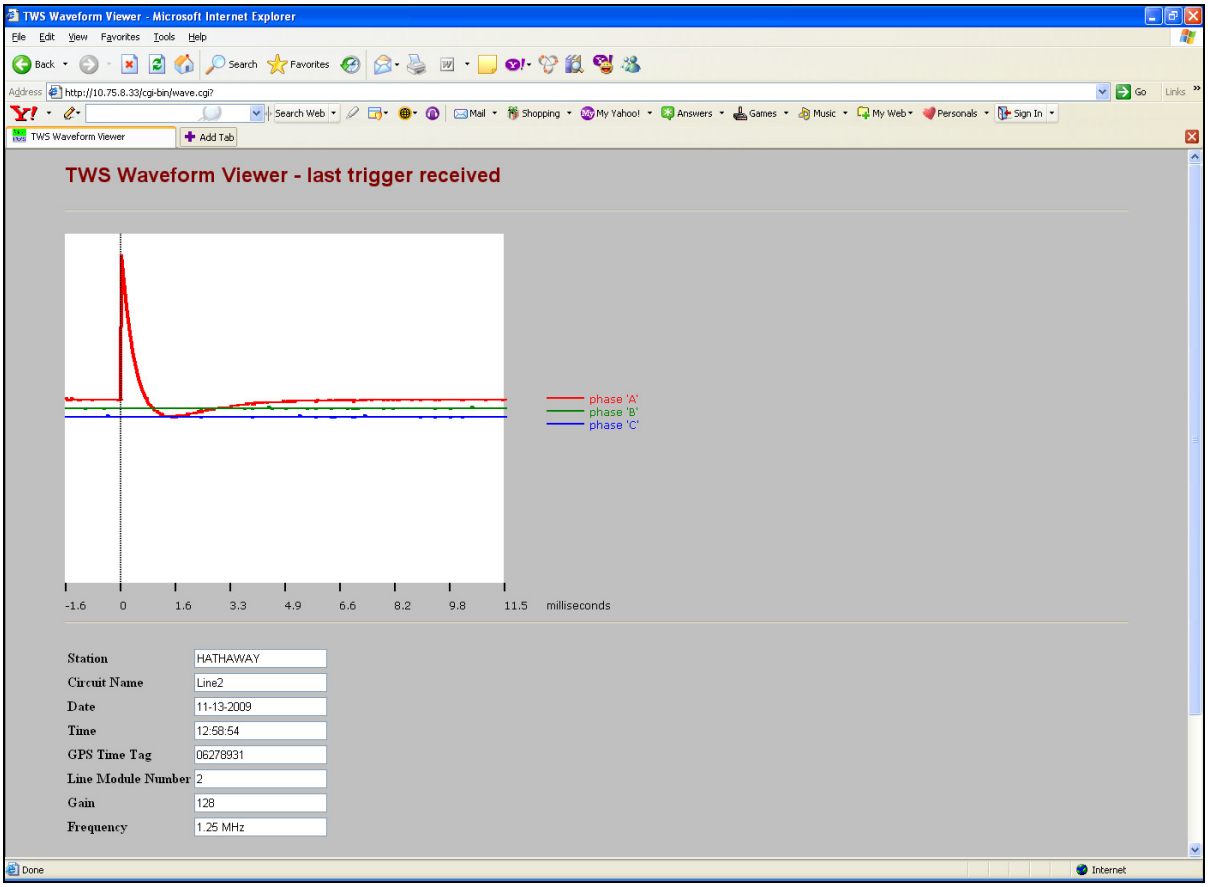
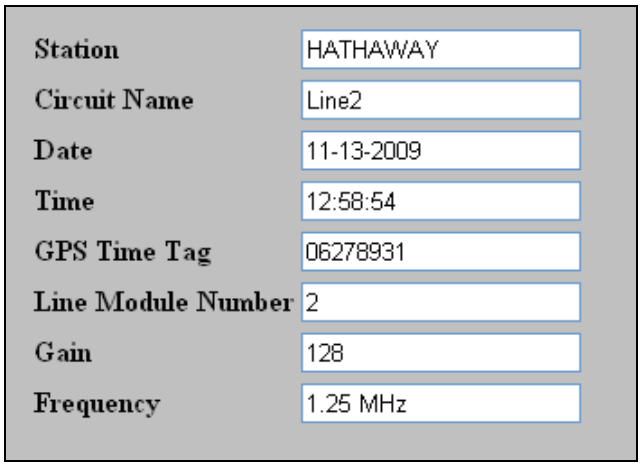
The diagnostic report contains details of the TWS settings, the number of triggers on each line module and a list of alarm conditions, for example loss and gain of GPS synchronization.

TWS Waveform Viewer

When the Waveform button is clicked the screen below will be displayed showing the last recorded waveform from the TWS. This is a very useful tool during the commissioning procedure for testing Analogue line operation (see section 5.9 for more detail).



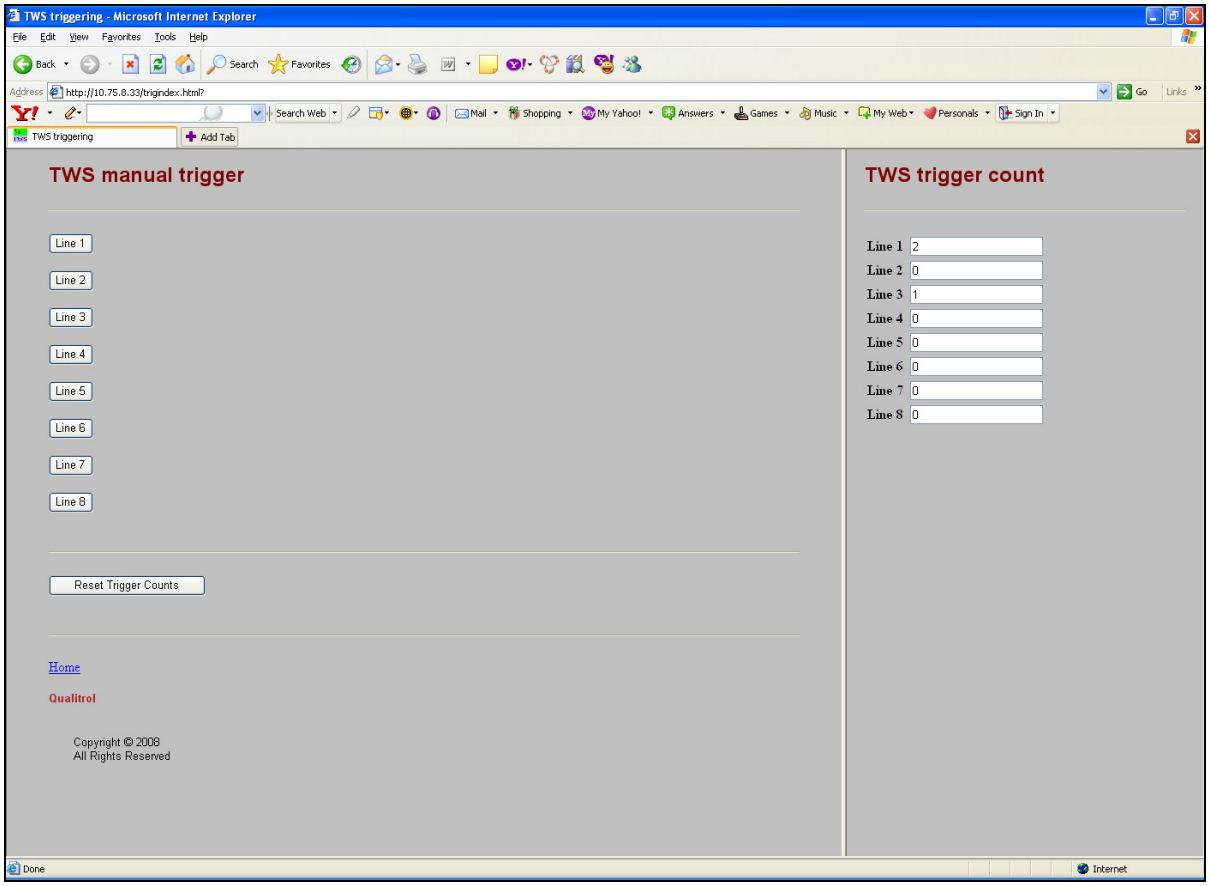
Scrolling down the page we can see the information about the trigger such as the Station name, Circuit name, Date and Time Tag.



TWS Triggering

When the Trigger button is clicked the screen below will be displayed. By clicking Line 1 to Line 8 a remote manual trigger is sent to the TWS. The TWS trigger count on the right hand side of the page will increase.

The Trigger count can also be reset to zero by clicking Reset Trigger Counts.



5.8. Remote Communications

The next stage in commissioning is to ensure that the user can establish communication to the TWS from the Control Room by modem or Ethernet.

The requirement at this stage therefore is for a PC in the Control Room. This PC should have TWSBase2000 installed.

Refer to the TWSBase2000 User Manual to establish remote communications to TWS.

5.9. Analogue Line Operation

This stage of testing will confirm the Line module operation, prove the transducers and their connections, and confirm that phasing and polarity have been maintained throughout the wiring.

This is checked using a low voltage battery and a length of wire. After looping the wire through the transducers as described below the user shorts the wire across the battery momentarily causing an impulse to be generated.

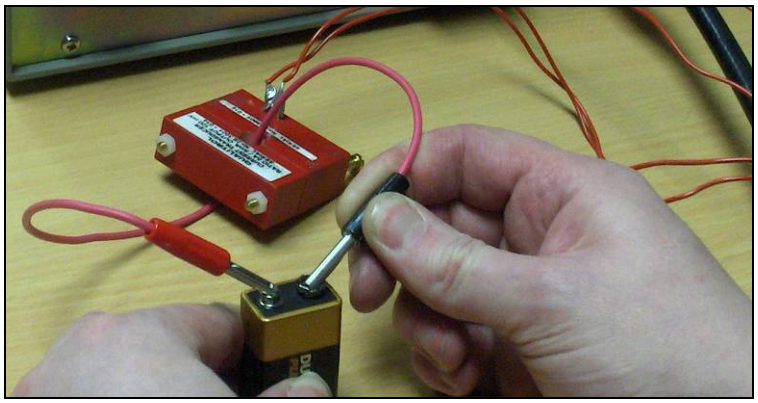


Figure 34 - TWS flick test on a table top

Two operators are required with easy communication between them. The procedure is:

1. Inject a pulse through the Phase A transducer on Line 1.
2. Check waveform on TWS webpage as described in section 5.6.2.
3. Repeat for Phase B.
4. Repeat for Phase C.
5. Repeat with the current loop going through the Phase A Transducer and Back through the Phase B Transducer in the opposite direction.
6. Repeat with the current loop going through the Phase B Transducer and Back through the Phase C transducer in the opposite direction.

This confirms the correct association of transducers with phases for Line 1 and that they are connected with a consistent polarity.

If the results do not come out as expected correct the installation and or wiring to achieve the correct result, and repeat the test.

Repeat the test for each line.

5.10. Check Alarm Operation

5.10.1. Power Supply

Switch the TWS off and ensure that an alarm is received via the Substation Alarm System. If no alarm is received, check that the alarm contact is closed by checking the continuity on the socket at the rear of the TWS. If the alarm contact is closed check the substation wiring.

5.10.2. GPS Fail Alarm

When the GPS receiver does not have satellite acquisition for more than 15-20 minutes, the GPS Fail alarm contact will close.
To check, remove antenna from GPS Module and after 15 -20 minutes check that an alarm is received via the Substation Alarm System.
If no alarm is received check that the alarm contact is closed by checking the continuity on the socket at the rear of the TWS.
If the alarm contact is closed, check the substation wiring.

5.10.3. Watchdog

The watchdog alarm will be received when the TWS is initially switched on. The alarm will disappear approx. 3-5 minutes after the TWS is initialised.

5.10.4. Trigger Alarm

Ensure that when the TWS is triggered an alarm is received via the substation alarm system. If no alarm is received check that the alarm contact is closed when the TWS is triggered by checking the continuity on the socket at the rear of the TWS. If the alarm contact is closed check the substation wiring.

5.10.5. Operational Checks

Apart from triggering from system transients some customers may wish for further assurance of correct operation, and in this case it may be possible to generate transients by closing a circuit-breaker onto a dead line. TWS operation can be confirmed without any fault being present on the system. This Type E test is further explained in Appendix E.

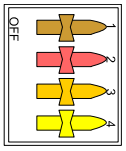
5.11. Installation of Additional Line Modules

Additional line modules may be added by the user, up to a maximum of 8. They should be added into the next available slot position, i.e. if slot 1 & 2 are already occupied, position 3 should be fitted with the next line module.

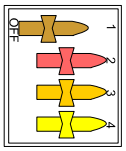
When installing the new line module(s) all usual anti-static precautions should be observed. Before installing the line module the address of the line module must be set by the onboard switch. The switch setting will be dependent on the line module position in the chassis and should be set according to the following chart.

When the installation is complete and the TWS is switched back on, the additional Line Module(s) will automatically be detected by the software. This can be checked by looking at the diagnostic file on the web page and checking that the additional Line Module is shown as ‘normal’.

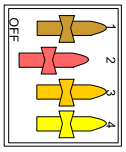
The trigger tests should be carried out on the additional Line Module(s) as described in Section 5.9 to confirm correct operation. Changes to the ‘CONFIG.TWS’ file should be made as described in Section 5.7, if required.



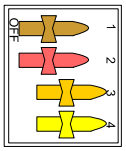
Line Module 1



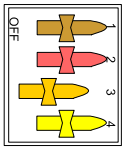
Line Module 2



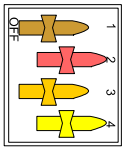
Line Module 3



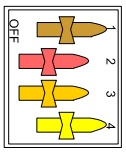
Line Module 4



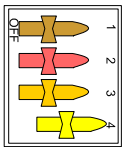
Line Module 5



Line Module 6



Line Module 7



Line Module 8

TWS Line Modules Address Switch Positions

The above figure assumes that switch position 1 is nearest to the capacitor C67 next to switch. Observe the OFF position of switch.

Appendix A – Installing an External Modem

Overview
On some occasions a customer may wish to use an external modem to communicate to their TWSs. This section details the steps taken to make the communications between the TWSbase2000 software and the TWS work when using an external modem.

Description
While any serial external modem can be used, for this example a FastTrack Wavecom GSM modem model number M1306B was used for communications to the TWS.

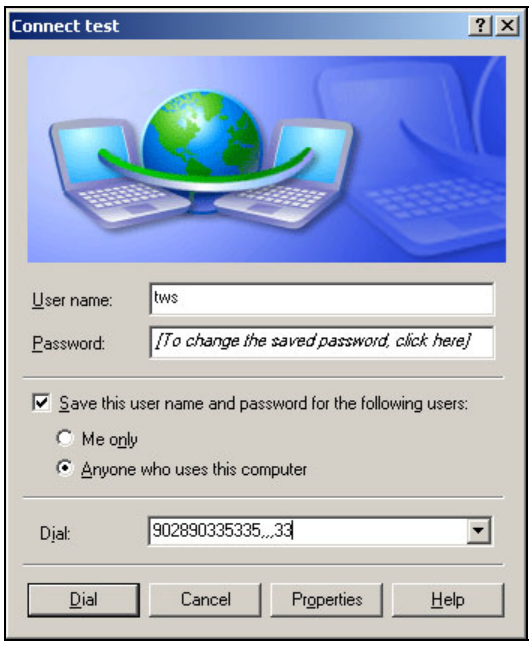
The external modem requires an initialisation string from the TWS. This initialisation string does a number of things one of which is to set the external modem to auto answer calls. When the TWS MkVI boots up, it sends an initialisation string out Com Port 2. The TWS MkVI default initialisation string is set for Hayes Compatible modems and in most cases will not need to be changed. Com Port 2 can be found on the Dongle/Ethernet assembly at the back of the TWS. The Com Port 2 on a TWS is set by default to communicate at a baud rate of 115200.

If necessary, see section 5.6.1 on how to configure the baud rate and initialization string of an external modem by TWS web page.

Procedure to fit modem to TWS

1. Power the TWS down.
2. If using a PSTN modem then connect the modem to a telephone line.
3. If using a GSM modem then ensure the network providers “Sim” card is enabled and installed in the GSM modem.
4. Power on the external modem and configure the modem to communicate at 115200 baud rate (refer to the modems user manual.)
5. With the external modem still powered on connect the external modem to com port 2 found on the rear of the TWS.
6. Power up the TWS.
7. The TWS will send an initialisation string to the modem.
8. The modem will be ready for use.

Procedure to configure TWS base station for modem
Once the TWS has booted up use windows dial up wizard to create dial up connection and dial the external modem. An example dial up connection is shown below. User name is **tws** and password is **hathaway**.



If configured correctly the windows PC should successfully dial and connect to the TWS.

Trouble shooting external modem communications
If a connection is not successful then try the following suggestions.

Check that the ribbon cable coming from the Com Port is attached to the correct connection on the CPU board.

Ensure that the baud rate of the external modem matches the baud rate setting on the TWS. If using a GSM modem ensure the network provider has configured the “sim” card as:

- Circuit Switched data number
- 8 data bits, No Parity bits, 1 stop bit
- Non-Transparency enabled (also known as error corrected or RLP)

The TWS sends out an initialisation string to the external modem during bootup therefore ensure that the external modem is turned on and booted up and connected to com port 2 of the TWS before the TWS is turned on.

Try lowering the baud rate setting of the com port and external modem from 115200 to 9600. The recommended method is via web page as described in section 5.6.1 of this manual.

Appendix B - Upgrading a TWS

The TWS application software upgrade consists of two files, *tws.tgz* and *tws_auto_install*. These files are available from QUALITROL (typically via eMail). The upgrade can be performed remotely over a communication link.

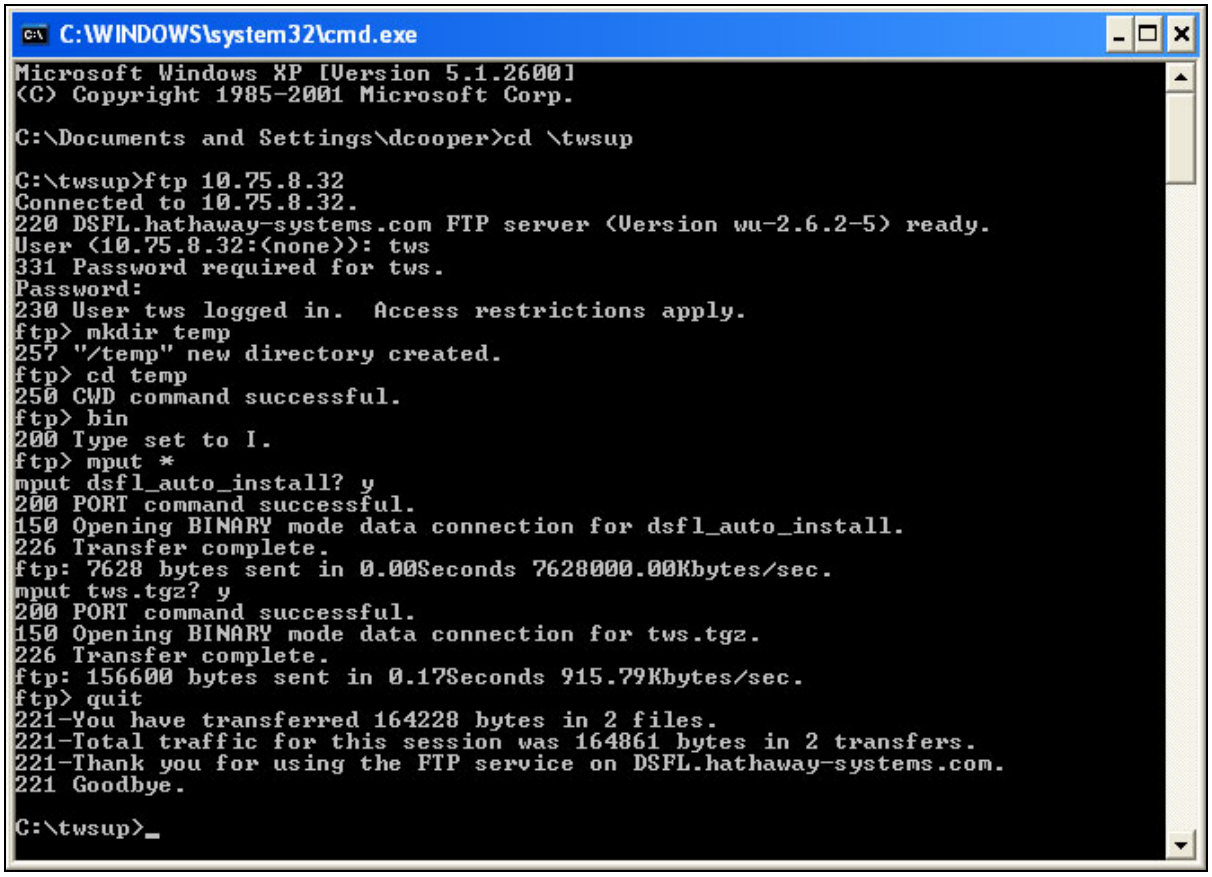
The upgrade process is shown here using Windows XP. Other operating systems may be used to perform the upgrade. Please contact QUALITROL if you require assistance doing this.

1. Find the directory containing the files *tws.tgz* and *tws_auto_install* used for upgrading the TWS. Make a directory on the PC (c:\twsup for example) and copy these two files into this directory. This directory is referred to as the TWS install directory, and c:\twsup will be used to illustrate the procedure below.

2. Where necessary, establish a dial up link to the TWS (Note that the IP address used in this example is that for a dial up TWS '200.100.51.34').

3. Open a DOS Command prompt window on the PC. Then type the following commands to use FTP to the TWS.

Change directory	**cd \twsup (TWS install directory created in step 1)**
Start FTP	**ftp -i 200.100.51.34**
Login as user	**tws**
With password	**hathaway**
Make temp directory	**mkdir temp**
Change directory	**cd temp**
Set mode for binary transfer	**bin**
Transfer files	**mput ***
Close the FTP session	**quit**


C:\WINDOWS\system32\cmd.exe
Microsoft Windows XP [Version 5.1.2600]
(C) Copyright 1985-2001 Microsoft Corp.
C:\Documents and Settings\dcooper>cd \twsup
C:\twsup>ftp 10.75.8.32
Connected to 10.75.8.32.
220 DSFL.hathaway-systems.com FTP server (Version wu-2.6.2-5) ready.
User (10.75.8.32:(none)): tws
331 Password required for tws.
Password:
230 User tws logged in. Access restrictions apply.
ftp> mkdir temp
257 "/temp" new directory created.
ftp> cd temp
250 CWD command successful.
ftp> bin
200 Type set to I.
ftp> mput *
mput dsfl_auto_install? y
200 PORT command successful.
150 Opening BINARY mode data connection for dsfl_auto_install.
226 Transfer complete.
ftp: 7628 bytes sent in 0.00Seconds 7628000.00Kbytes/sec.
mput tws.tgz? y
200 PORT command successful.
150 Opening BINARY mode data connection for tws.tgz.
226 Transfer complete.
ftp: 156600 bytes sent in 0.17Seconds 915.79Kbytes/sec.
ftp> quit
221-You have transferred 164228 bytes in 2 files.
221-Total traffic for this session was 164861 bytes in 2 transfers.
221-Thank you for using the FTP service on DSFL.hathaway-systems.com.
221 Goodbye.
C:\twsup>_

4. Open a telnet session from the PC to the TWS. This can be done using the command prompt:

Command	**telnet 200.100.51.34**
Login as user	**tws**
With password	**hathaway**

5. In the telnet session, become the root user:

Command	**su -**
With root password	********

6. Change directory to that created in step 3 using the command:

Command **cd /home/tws/temp**

7. Change permissions on the *tws_auto_install* file to make it executable:

Command **chmod 755 tws_auto_install**

8. Upgrade the TWS using:

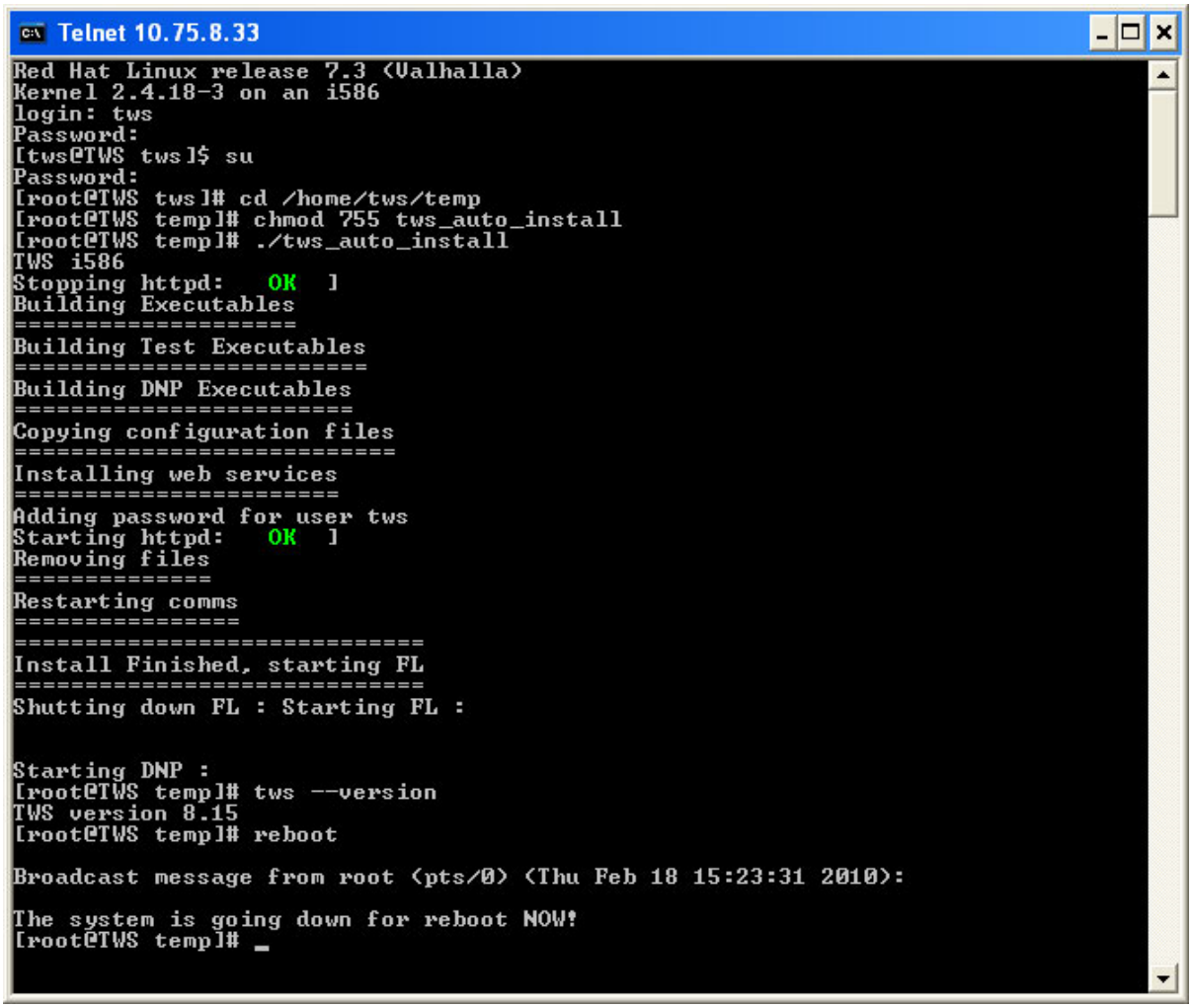
Command **./tws_auto_install**

Confirming successful installation
In order to confirm that the upgrade has been completed successfully, in the telnet session type:

Command **tws --version**

This command will show the currently installed TWS version number along with information about how long the current instance of TWS software has been running for.
It is recommended to reboot the TWS once the software upgrade is completed.

Command **reboot**



Appendix C – Telephone line simulator

When performing commissioning dial up tests to the TWS the following equipment can be used to simulate a telephone network.

Company: Good Thinking
Telephone: 01844-291803
Product: Freelink Demo Dual Line

Appendix D – TWS Mark V DNP Option

Introduction
The TWS/DSFL DNP program provides an implementation of the DNP3.0 protocol that enables a DNP Master station to collect event trigger information from the TWS/DSFL device.

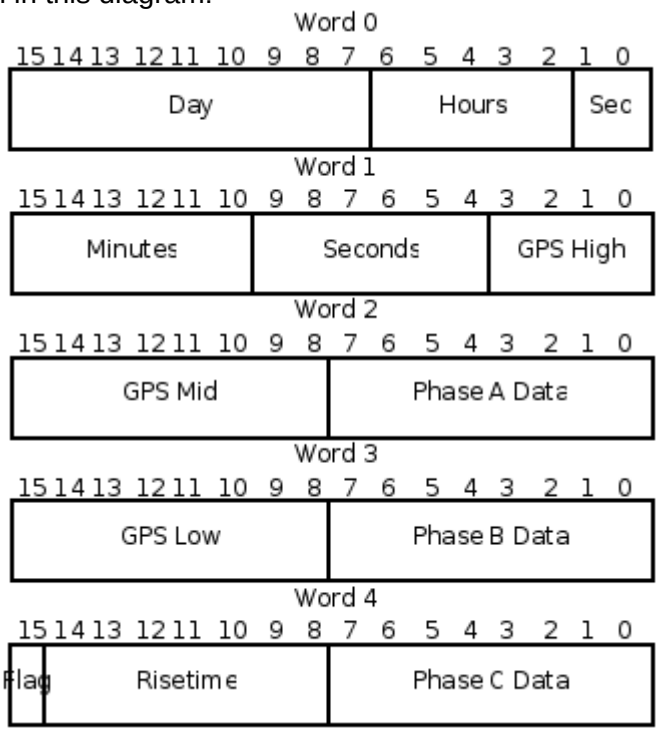
The program is a standalone application that is independent of the TWS/DSFL application and performs demand scanning of the TWS/DSFL file system to identify and get details of system events reported in the index files from the line subdirectories. Scanning for events occurs when a DNP master station reads analog data, or requests DNP class reports from the TWS/DSFL.

The TWS/DSFL application files are scanned to identify the most recent events, and the event details are entered into a reporting queue Each line's queue has a user settable maximum depth of up to 500 entries, the default value is 10. Event details are derived from the event summary file, found in the line's subdirectory.

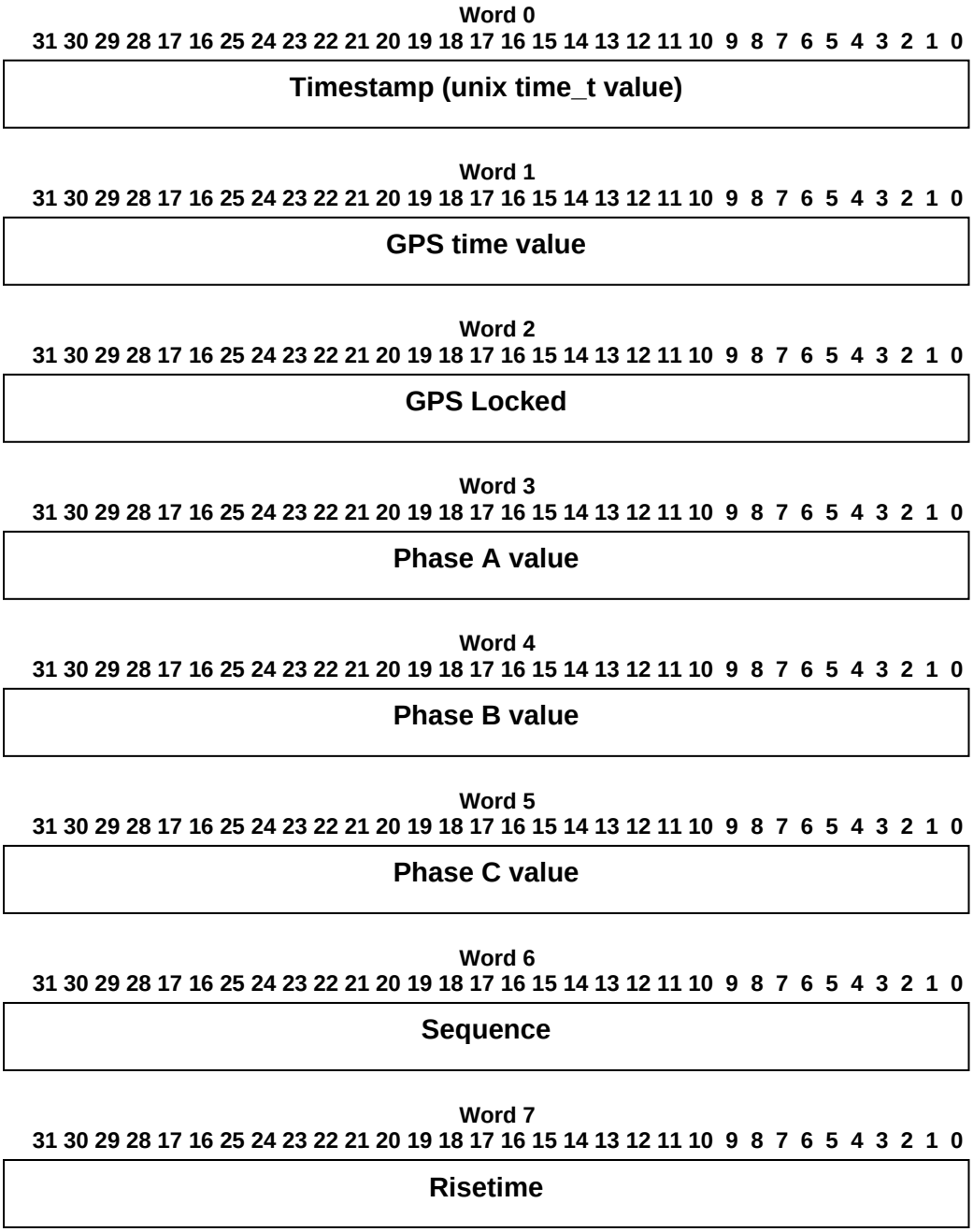
The application reports the event details in one of two formats selected by the program's configuration. Only one format is operational depending on the configuration, the other variation will be rejected by the program if requested. The format selection determines if each line's events will be reported as 5 16-bit registers (reported as DNP variation 2, 16 bit value with flag), or as 8 32-bit registers (reported as variation 3, 32 bit values without flag).

For either configured format the reports can be read using a direct read command for Object 30 (Analog Input) or retrieved as events using Object 60 (Class Object scans).

The default event report format is the 16-bit with flag format. Note that the flag value sent by the application is always 1 in this report format. The events are encoded as 5 16-bit values as shown in this diagram:



The 32-bit format sends each value as a separate register. The events are encoded as 8 32-bit values as shown in this diagram:



For all formats the event reporting behaviour is the same. The current event queue entry is returned to the DNP master station when an Analog Input read or a Class 0, 1, 2, or 3 request is processed. The queue is shifted when the application confirm message is received for a Class 0, 1, 2, or 3 response.

Class 0 responses will continue to contain all the current event values; Class 1, 2, and 3 requests will return no data if all current events have been acknowledged.

DNP Protocol Summary

The DNP program implements a very basic subset of the DNP 3.0 protocol. The implementation is based on the TWS Mark III DNP program, and intends to provide the same capabilities and functions of that program.

DNP operations over serial lines and TCP/UDP have been implemented. Selection is based on the command line used to invoke the program.

The internal indicators transmitted by the protocol only support the Restart Flag, indicating that the DNP subsystem has been restarted. This flag can be reset by the master write to the Internal Indications (object 80). The class data indication flags are not used by this implementation.

The implementation will support the following Data Link control frames:

Reset Link	responds with Ack response always
Reset User Process	responds with Ack response always
Test Link	responds with Ack response always
User Data (send/confirm)	responds with Ack response always
User Data (send/No Reply)	responds according to Transport content
Request Link Status	responds with Ack response always

The implementation will support the following Transport Frames:

Sequence number echoed from received message.

The implementation understands the following Application function codes:

Confirm	no action taken unless response outstanding
Read	Process object requests as detailed below (all read responses request app confirm)
Write	Process object writes as detailed below

All other application functions ignored

The implementation supports the following DNP 3.0 objects:

Binary Object (1)

Read	Returns Variation 2 (binary with status) Constant data and status for 8 objects: 0 online, 0 online, 0 offline, 0 online, 0 online, 0 offline, 0 online, 0 offline
Write	Not supported

Analog Object (30)

Read — Returns Variation 2 (16-bit value with status)
Current event values as requested by the user (start, stop indices or all values). Object numbers 0 through 39

or

Returns Variation 3 (32-bit value)
Current event values as requested by the user (start, stop indices or all values). Object numbers 0 through 63

Write Not supported

Time and Date Object (50)
Read Variation 1 only. Returns the current time in the TWS/DSFL
Write Acknowledged but ignored to ensure GPS time is used

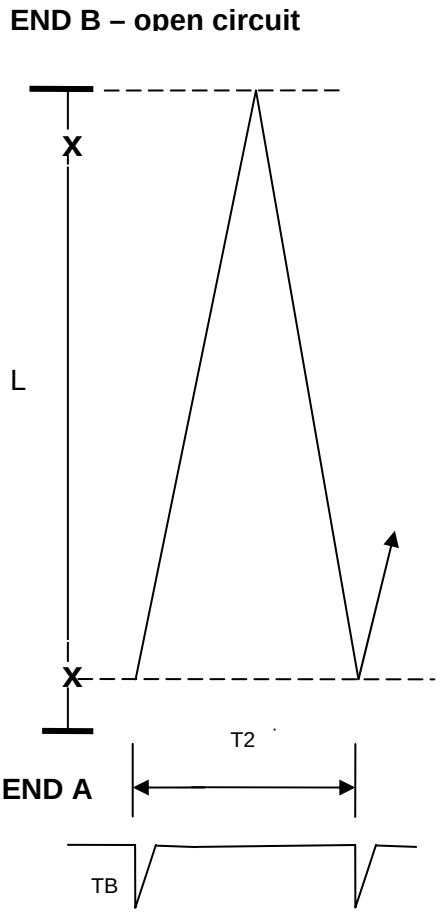
Class Data Object (60)
Read Returns latest event for 8 lines
40 Analog objects Variation 2 (16-bit analog with status)
or
64 Analog objects Variation 3 (32-bit analog)
Write Not supported

Internal Indication Object (80)
Read Not Supported
Write Performs Clear Restart operation

More detail including a DNP V3.00 device profile is available in the TWS/DSFL DNP QUALITROL document 40-8564. See section 5.7.1 of this document for a description of the DNP web page interface to the TWS/DSFL.

Appendix E – Type E Test to Energise a Dead Line

Type E testing is normally carried out to confirm the length of the line being monitored. It can also be used, however, to test the TWS principle. The line is energised by closing the circuit breaker at one end with the other end being open and preferably isolated. Energising a dead line generates a travelling wave that will be fully reflected from the open circuit at the far end. An operator uses TWS Base Station software to identify the reflected pulse and measure a distance equivalent to the line length. The following lattice diagram gives more information:



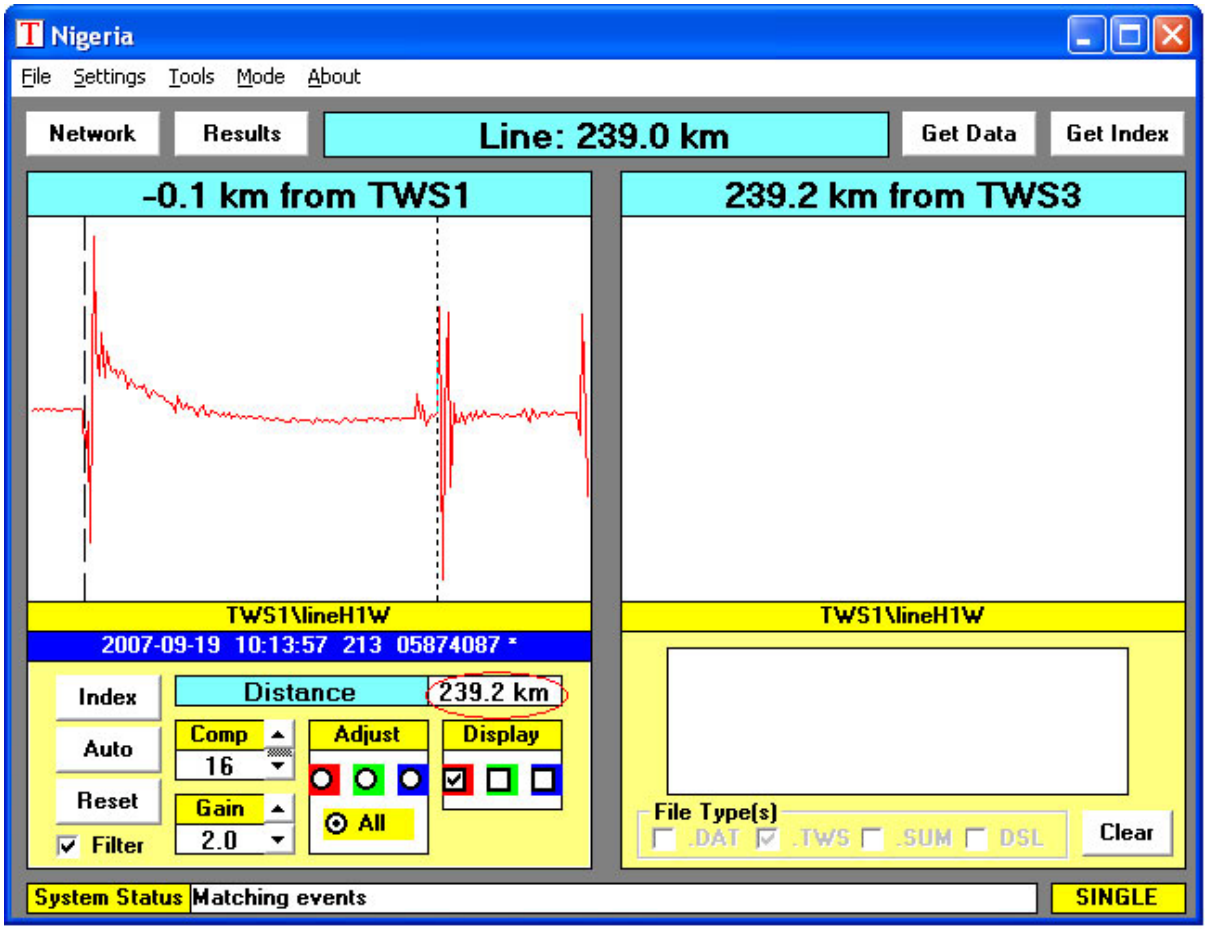
Line Length (L) = [T2 x v]/2
Where v = propagation velocity

Note that it is unlikely that the TWS at End B will trigger therefore a double ended Type D automatic method of measuring the line length may not possible. The waveform captured at End A has to be analysed manually.

Note that Type E testing will not be successful if the circuit breaker closing control is designed to operate at voltage zeroes. Closing each phase on a voltage zero will not generate a travelling wave.

Energising a Dead Line from End A
Note that a TWS will not normally trigger when a circuit breaker is opened and a line de-energised.

An example of a Type E test is shown below.



An operator manually positions the vertical dotted cursor at the foot of the reflected pulse to measure the line length. In this case it is 239.2km

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